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CREEPING AND WALKING.

By AUGUST W. TRETTIEN.

When we look upon an infant which is just taking its first breath of vital air, we cannot but feel the full import of Linnæus's definition of it, when he said—"Naked and without weapons."

Other mammals possess natural means of protection and defence; some wear a warm fur, others possess agility and swiftness of foot soon after birth, but man has nothing of the kind for many months after he begins his separate existence.

We are also struck with the peculiar purposeless character of the movements of the human infant, apparently without control or rhythm, without administering to the immediate necessities of life. An infant, come to make its way through a life of necessity with only a possibility as its individual heritage.

On the other hand, we look upon man in his full possession of power and stature and contrast his form and appearance with that of other vertebrate creatures, we are equally struck with his capability of assuming an attitude which is distinctly his own, which has been termed the erect attitude. In this position the head is balanced perfectly upon the summit of the spine; the inferior extremities are elongated and brought into straight line with the body for support and locomotion, and the superior limbs hang gracefully at the side of a beautifully curved trunk. As Huxley says—"he stands raised up as on a mountain top, far above the lead of his humble fellows, and transfigured from his grosser nature by reflecting, here and there, a ray from the infinite source of truth."[1]

The whole position is in striking contrast with the attitude

[1] Man's Place in Nature. p. 132.

of the fishes of the sea, the fowls of the air or the beasts of the fields, whose long axis of body is parallel with the surface of the earth over which they move.

It is indeed strange that this erect attitude of the human body, which conjoins with it the discharge of the highest faculties of man, has not been heretofore a subject of more extended investigation.

It is the purpose of this study to trace the various stages and attitudes assumed by the infant and the movements which it employs in passing from this helpless stage of infancy to the time when the straightness and uprightness of body is taken. The data upon which this study is based, has been carefully selected from Medical Journals, Hospital Reports, and from the returns of a syllabus on the Straightness and Uprightness of Body. These returns have been the direct observations of individual cases and the writer has sought to verify the results by personal observations.

The Embryo.

Before we can approach the problem as it is presented to us in the infant at birth, it is necessary to consider briefly some of the determining factors during the embryonic life. At the stage of fœtal life when the embryonic body takes shape out of the embryonic disk, there is a conspicuous enlargement of the head and neck, as compared with the body, accompanied by a dilatation of the medullary canal to form the brain. Shortly the head makes a distinct bend forward and downward at about its middle, and the posterior end, which at first curves slightly upward, curls over ventrally, and as the back curves with it, the dorsal outline of the entire embryo becomes convex. This convexity increases so that in the embryo of about 30 days' growth the head and tail closely approximate, having the (Fig. 12 72, p. 190, Vol. III, Buck's Rep. H. Book, m. sc.) form of the letter C, and is from four to eight mm. in length on the straight line.

The anterior and posterior limbs have already made their appearance as small buds on the two sides of the body. Soon the fore-arm, the leg, and the arm and thigh successively make their appearance.[1] M. Hamy took the measurements of Zue, Gunz and Liharzic, and showed that at about the fourteenth day of intrauterine life the fore-arm of the European is longer than the humerus, while from two and one-half months the humerus grows proportionately faster. At this period the ratio existing between the fore-arm and the arm is 88 to 100, at birth this ratio

[1] Topinard: Anthropology, p. 141. Reference Hand Book of Medical Science. Dr. Buck, Vol. III. Embryology. Dr. Minot.

is 77:100, and at maturity 72:100. The femur is also relatively small during this early period.

During the time to the fiftieth day of growth a well marked change takes place in the external form of the embryo. The body now becomes nearly straight, with an area about the same as that of the head; the limbs are distinctly divided into an upper and lower division; the hand makes its appearance with notches along the edge of the distal end from which converging grooves run; and two weeks later the five digits are well developed. The lower limbs are also divided, the feet are plainly marked, and the toes are becoming free. On the whole the development of the posterior extremities is outstripped by that of the anterior. The bend in the neck has diminished from a right angle to an obtuse angle. At the period of two months the embryo has a distinctly human appearance in all parts, despite the disproportions of the same. There is now an increased development of the legs and feet and the disappearance of the free tail. (Fig. 224, Minot, p. 392.) Measurements of the extremities of different fœtal skeletons at the approximate ages of four, six and eight months give the following results:

Length of Fœtus. Length in Inches.	Length of Spinal Column.	Length of Arm.	Length of Leg.	Age. Approximated According to Hacker.
7.80	4.12	2.72	2.80	4.4 mos.
10.77	4.94	3.86	4.07	5.4 "
15.70	6.67	5.51	6.18	7.9 "

The following table expresses the ratio of the extremities:

Age.	Length in Inches. Body.	Arm.	Leg.	
4.4 mos.	7.80	100	102.9	
5.4 "	10.77	100	105.6	
7.9 "	15.70	100	112	
17 "		100	136	
[1]Adult.		100	143	Taken from Hamy's Measurements.

Position in Utero.[3]

The position which the fœtus assumes in utero without doubt determines the position of the extremities with reference to the

[1]Topinard Anthropology, p. 85.

* The manner of estimating the age of these embryos was taken from Hacker's measurements, which show that the fœtus at three and four months is three and four inches respectively, at five, six, seven and eight months the average length may be determined in inches by doubling the time; at nine and ten months the length is seventeen and eighteen inches respectively.

*Diseases of Infancy and Childhood, Dr. Holt.

[3]Minot: Embryology, p. 394.

body for some weeks after birth, and consequently the early movements are affected.

In utero the head is bent forward, the back contains one continuous concave curve forward without the lumbar convexity of later development; the extremities are drawn toward the body, the arms are bent forward and crossed over the breast with the fingers touching; the legs are raised forward, the right leg nearly always straight across the body with the toes resting against the forehead, while the left leg is bent at the knee bringing the left foot against the right thigh. In another position, the legs are crossed over the lower abdomen. The babe rests generally upon the right side. This attitude gives the muscles the greatest relaxation, and to the cartilage, which caps the bones, the position most favorable to nutrition and growth. At the same time the embryo forms as nearly as possible an oval, and thus occupies the smallest possible space.

Prenatal Movements.

It is believed by Professor Preyer and others that the movements of the infant immediately after birth do not essentially differ from the parental movements, except that they are given a wider range. The parental movements are entirely purposeless and are spontaneous or reflex. The former are those movements which are due to diffused stimuli from the growth of the lower motor centers, the latter movements immediately follow external stimulation. Professor Preyer states as a certainty that these movements are present in an embryo at five months' growth, and to substantiate this statement he cites an experiment of Erbham, which shows conclusively that even at four months the movements are possible from the stage of development of the muscular and nervous systems. Erbham placed a four month fœtus into a small vessel of warm water which furnished a sufficient external stimulus to cause a contraction of the muscles of the extremities and neck, to move these members in a natural manner. For one-half hour it was observed that the limbs moved before the body and the head turned from side to side.

Medical writers who place the evidence of movements considerable later, usually refer to the larger movements of swallowing, clasping and stretching as outgrowths of he simpler reflex movements to which Prof. Preyer refers.[1]

Like every other organic formative process, the origin of the human body and of its nervous system appears as an expression of a life process in course of progress, the beginning of which we do not know. What we do know is that very early in

[1] Preyer: Physiologie des Embryo, p. 431.

the embryonic life, when the body and nervous system attain a certain stage of development, a disturbance without causes a nerve stimulus which in turn produces muscular contraction. The infant, before birth, is living in an environment where the external stimulation is limited, the amniotic fluid in which the fœtal body rests is of uniform temperature with the body, yet it receives peripheral stimulation which is transmitted to it from the body of the parent—the beating of the heart, the movements of respiration, the change of position and posture and the movements of walking, all have their direct influence in stimulating the organism of the fœtus.

These stimuli start the nerve mechanism which has become so complicated and interrelated that a given irritation never affects one cell only, but rather is conducted from a point in the periphery by the fiber to a nerve center which may innervate a large collection of motor cells. A subsequent stimulus in like manner excites a sensory cell, which according to the anatomical relations of the sensory and motor cells, may bring an entire system of muscles into contraction.

In this manner Exner has explained how a single sensory impression may lead to a complicated movement in which many muscles take part. There is a close relationship, says Edinger,[1] established between the different sensory nerves and their motor reactions, and there is much evidence in favor of the view that such relationships, when once established in the course of evolution, are afterwards inherited. The nervous system, then, consists of two parts—one part, which is congenital and arises from the primordial racial exercise (phylogenetic), and the other part (ontogenetic), which derives its relationship only during the individual person's life.

The congenital mechanisms are found in the nervous system of the embryo and predominate in the sympathetic system and in the medulla and pons. The latter centers correspond to Hughlings-Jackson's lowest level, in his three-level theory and control the simple reflex movements.

The Infant at Birth.

[2]A study of the infant at birth shows that it is a being still very different from the adult in the structure and composition of its organs as well as in the relative proportions of the members of its body.

The data for the study of new born infants is still very limited beyond that of the bare measurement of length and weight.

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[1] Edinger:
[2] Am. Jour. of Obstetrics, Vol. XXXVII, 1898. Dr. Wilson.

[1]The length of the infant at birth is about ⅓ of that of the adult. The average length has generally been taken as 50 centimeters (19.68 inches) for males and 49.50 centimeters (19.48 inches) for females.

The normal range of boys in height, as shown by the Report of the Anthropometric Committee of the British Association for the advancement of Science, is from 15 to 24 inches and of girls is from 16 to 23 inches.

The weight of an infant at birth is about $\frac{1}{19}$ of the adult weight. The average weight of a healthy child born at full time is 3,333 grams (7.3 lbs.) for males and 3,200 grams (7.1 lbs.) for females.

Again stating the figures of the Anthropometric Committee the boys range in weight from 3½ to 11½ lbs., and the girls range from 4½ to 10½ lbs. The report of the committee is based upon the measurements of 451 boys and 466 girls in London and Edinburgh hospitals and represents largely the measurements of the lower and middle classes of society. The parents were English and Scotch and represented city and country people. The measurement of the length was taken in a recumbent position and the weight without clothes.

Relative Proportions of the Parts of the Body.

While there are very great individual differences in infants in their stature, there are certain proportions which are maintained at all periods of growth between height and width. According to Dr. Uffelmann,[2] in the normal child, the measurement across the shoulders should equal about ¼ of the length of the entire body. An important difference is disclosed between boys and girls at birth. In stature and weight the girls are nearest the average type; in form the boys' shoulders and hips measure the same across; in girls, the shoulders measure a little less.

The following tables are given to show the relative increase of the different parts of the body at various periods of growth. Zeising's measurements represent a general law of proportion of the normal child, the measurements are taken from the crown to the hip and from the hip to the heel. At birth these measurements are about equal. Letting the whole length from head to heel be represented by 1,000 in each case, the relative length will be expressed as follows:

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[1]Vierordt K.: Anatomische, Physiologische und Physikalische Daten und Tabellen.

[2]Dr. Uffelmann: Domestic Hygiene of the Child, p. 7.

[1]Birth	$\frac{500}{500}$						
1 year	$\frac{478}{522}$	Increase of lower limbs			$\frac{22}{1000}$	in one year.	
2 years	$\frac{457}{543}$	"	"	"	$\frac{21}{1000}$	"	"
3 years	$\frac{439}{561}$	"	"	"	$\frac{16}{1000}$	"	"
5 years	$\frac{415}{585}$	"	"	"	$\frac{12}{1000}$	"	"
8 years	$\frac{397}{603}$	"	"	"	$\frac{6}{1000}$	"	"
13 years	$\frac{382}{618}$	"	"	"	$\frac{3}{1000}$	"	"

Growth in length of parts of body according to Liharzik's table.

[2]Representing length at birth by 100.

	Birth.	End of 21 month.	7½ year.	Adult.
Head,	100	150	191.7	200
Forehead,	100	114	150	157
Lower portion of face,	100	200	250	260
Neck,	100	500	700	900
Chest,	100	186	300	314
Abdomen,	100	160	240	260
Leg,	100	200	455	472
Arm,	100	182.5	325	350
Upper,	100	183	328	350
Lower,	100	182	322	350

The proportions of the infant's body are very different from those of the adult. The new-born has a very small and narrow thorax compared with the abdomen, and the pelvis as a region scarcely exists. The whole trunk thus assumes an oval form with the small end toward the neck.

[3]The anterior diameter of the thorax at birth at the level of the 2nd costal cartilage is as 2 to 3, while in the adult it varies from 1 to 2½ or 1 to 3. The sternum is relatively smaller than in the adult male, but not very different from some very small breast-bones which are occasionally found in women. The shoulders are very small, which make the chest appear quite different. The pelvis is so small that it forces the pelvic organs of later life more or less into the infant's abdomen.

Composition and Structure of the Body.

Bones. The composition and structure of the infants' bones are very different; the bones are softer and more vascular, the marrow is vastly more dilated with blood vessels. An ex-

[1]Gerhardt: Handbuch der Kinderkrankheiten, pp. 267 and 269.
[2]Gerhardt: Handbuch der Kinderkrankheiten, p. 272.
[3]Dr. Rotch: Pediatrics.

tremely important difference is noticed between the spine of the new-born and the adult. In the infant the spine has little bone and much cartilage and fibrous tissue, making it light and flexible. The movements in the spine at birth are remarkable. Dr. Rotch ovserved that the spine of a child at birth, the abdominal visceral having been removed, could be bent easily so that the head touched the buttocks. The middle part was most flexible, the lumbar region seemed to be more pliant than the cervical. The lateral motion was quite free, though not without some torsion.

Curves. The spinal curves present an interesting and important condition.[1] In the infant, the whole dorso-lumbar region is concave forward, presenting one continuous curve from the neck to the sacrum, instead of the alternating convex curve forward in the region of the neck, a concave forward in the region of the chest vertebræ, succeeded by a convexity forward in the vertebræ of the loins. The adult vertebral column presents two sets of curves; the primary or dorsal and sacral curves which are present in quadrupeds, with them the human infant begins its independent existence, and the old man takes themto his earthly abode; and the secondary or cervical and lumbar curves. These secondary curves, says Dr. Turner—"are the characteristic spinal curves of man." But Professor Cunningham noticed them in the chimpanzee and also in some quadrupeds (*e. g.*, bear). This plainly indicates that the secondary curves can be associated with the upright position.

In process of development, as will be shown in the subsequent chapters, there are three distinct stages in which the spinal column assumes a characteristic curvature. First the natural continuous curve at birth. Second the curve which appears in the cervical region when the infant has learned to sit and to support its head erect upon the trunk. Third the additional dorsal and increased lumbar curves which make their appearance when the child is able to stand and walk erect. These characteristic curves may even be produced in an infant when it assumes different positions. When it is lying in a normal position the spinal column presents the long convexity, if the head is thrown back there appears a slight convexity in the neck, if in addition the legs are drawn out the lumbar region will spring forward. The latter positions are not, however, natural in the infant.

The relative lengths of the different curves are different in the infant compared with the adult. The following tables from Aeby and Cunningham will clearly show the ratios.

[1] Nature: Vol. XXXIII, p. 378, 1886. Report of Brit. Assoc. for Adv. sc., 1897, p. 771.

Relative lengths of adult spinal curves according to Aeby. Total length=100.

	Cervical Region.	Dorsal Region.	Lumbar Region.
Females,	21.5	45.7	32.8
Males,	22.1	46.6	31.3

Cunningham's ratio from 6 males and 5 females.

Females,	21.6	45.8	32.8
Males,	21.8	46.5	31.7

Relative lengths of spine curves according to Aeby's measurements of 5 and Cunningham's measurements of 3 infants.

Aeby,	25.6	47.6	26.8
Cunningham,	25.1	48.5	26.4

Other measurements of the lengths of infants' spines from the head to the sacrum.

		Absolute Length in M. M.				Rel. Length. Total=100.		
Observer.	Age of Infant.	Cerv.	Dorsal.	Lum.	Tot.	Cerv.	Dor.	Lum.
Rasenel,	3 mos.	50.·	100.	58.	208.	24.	48.1	27.9
Aeby,	6 "	52.5	103.	60.	215.5	24.3	47.5	27.8
Aeby,	6 "	53.5	107.	61.	221.5	24.1	48.6	27.5
Dwight,	10 "	61.	125.	77.	263.	23.2	47.5	29.2
Rasenell,	2 years,	70.	140.	90.	300.	23.3	46.7	30.
Aeby,	2 "	79.5	153.5	98.	331.	24.	46.4	29.6
Dwight,	3 "	78.	162.	101.	341.	22.9	47.5	29.6

The table, if continued, would show that after the 5th or 6th year the proportion remains about constant.

In spite of the individual variations and personal equations due to measurements of the different men, the tables show a marked uniformity. There is, it appears, a fuller development of the upper part of the skeleton at birth than the lower.[1]

The infant's spine thus approximates that of the quadruped until it attains the age of a year or sixteen months, which is the usual so-called creeping stage. At the time when the hips and the knee-joints are completely extended and gradually draw the leg into line with the thigh the alternating series of curves in the spine appear. In this position the center of gravity is brought directly over the base, which enables the being to stand and move about on two feet with the greatest ease and the least expenditure of energy.

Muscles. The muscles of the infant are very small and soft and not until the sixth month do they become firm and resisting. Certain muscles are more highly developed at birth than others. Thus a noteworthy difference is observed between the muscles of the arms and the legs. Although the gastro cnémius

[1] Rotch: Pediatrics, p. 56.

and the soleus muscles are developed sufficiently in body to form the calf of the leg, and the gluteus maximus is enlarged into the buttock, proportionally and in function these muscles are in a very rudimentary state compared with the muscles of the arms.

Dr. Robinson[2] found that in the case of sixty infants under one month of age, there was an exceedingly strong grip of the hands. He found that within one hour after birth they could hang by their hands onto the finger or stick ¾ of an inch in diameter, sustaining the weight of the entire body for a period varying from two seconds to one minute. Twelve out of the sixty could hang suspended ½ minute and four nearly a minute. This strength of grasp increased very rapidly after four days; nearly all ½ minute at that time. The faculty apparently attained its maximum development at two or three weeks, several children hung suspended over 1½ minutes, 2 hung a little over two minutes and 1 hung 2½ minutes. During that time of suspense no sign of distress or pain was evinced, no cry was uttered until the grasp began to give way.

This experiment shows that the hand and arm are developed functionally at birth, and the proportions are in striking contrast with the flexed position of the foot and thigh. The picture of a suspended infant reminded Dr. Robinson of a favorite chimpanzee "Sally" in the zoölogical garden.

The muscles of the neck are also in a rudimentary state of development; unless supported the head rolls off the infant's shoulders like a ball. The head can be rotated through an arc of 90° even without using the joint between the atlas and axis. The remarkable strength of the flexor muscles in the infant's body in comparison with the flaccid and feeble state of the entire muscular system is a striking phenomenon whatever may be its explanation.

Surface Anatomy.[3] Another exceedingly important difference between the infant and the adult will appear in a study of the surface anatomy of the spine. In the adult, especially in the male where the muscular system is well developed, there is a depression wherever the skeleton shows a prominence owing to the attachment of the muscles. The skeleton shows a ridge of spines in the middle line of the back, with a depression on either side; during the normal development of the muscular system there is a median furrow formed by two large masses of muscles in which the vertebræ appear prominent. In the infant this is not the case except in the neck. The back is rounded, later devel-

[1] Huxley: Anatomy of Vertebrate Animals, p. 414. Rotch: Pediatrics. Turner: Report of Brit. Assoc. for Adv. of Sc., 1897, p. 768.
[2] Nineteenth Century, Vol. XXX.
[3] Rotch: Pediatrics.

opment flattens the back and brings the spinous processes into prominence without the marked median groove. this appears only when the muscles of the back become fully developed. The laminæ, in the infant, look more directly back, and their presence in the median line is marked by knobs and ridges very different from the spine of the adult. Little change takes place in the appearance and proportions of the infant spine up to 18 months, but at three years the adult condition is very markedly approached.

Early Movements. If we compare the new-born human infant with young of other vertebrates generally, we find also a striking difference in its capabilities of assuming the characteristic attitude of its specie. The fish assumes its position and moves off in its element as soon as hatched; the chick can stand upon its feet immediately after it is liberated from the shell; the calf or colt follows its parent a few hours after birth. But the infant is most helpless of them all. The early movements of the quadruped are directed toward the end making for its existence. The movements of the human infant are vague, stretching, reflex actions, entirely purposeless, usually performed in a jerking manner, except in some cases the hand after several random attempts accidentally finds the mouth. There is no co-ordination of movements in the infant, but the movements are entirely spontaneous, arising from individual centers without any order or time of action so far as known, and not determined through the senses. Dr. Mumford[2] concludes that these spontaneous movements are not determined by forces in the environment, so far as we can see, but that the nerve centers which produce them act separately and respond as such to a specific stimulus—a reflex action; if you tickle the sole of the foot the member is withdrawn, place the finger in the palm of the infant's hand and the fingers close about it.

A further study of the movements of the infant, especially the movements of the limbs, shows how entirely purposeless they are. After a time these spontaneous movements diminish and disappear entirely or become transformed into surviving movements.

Dr. Mumford holds that, though these early infantile movements are aimless so far as the individual performing them is concerned, they are not necessarily meaningless as regards the development of the race of which the individual is an off-shoot. He believes that it is quite probable that these movements are vestiges of functions of the limbs which were of prime importance to the members of the race at another and an earlier period of its growth; but that they began to lose their prime

[2]Brain, Vol. XX, p. 290.

importance and consequently their full development when the fore-limbs of the race gradually acquired other and higher functions. The theory is suggestive and ingenious; but it is only suggestive. In the light of the preceding investigations let us turn to the returns of the topical syllabus. Although limited in number, the returns were quite full in detail and also unanimous in the conclusions based upon actual observations.

TOPICAL SYLLABUS.

Straightness and Uprightness of Body.

This circular seeks information from those who have access to children on any or all of the following points which are to be co-ordinated in a study of the many stages by which an infant acquires its power to get into and to maintain its upright position.

Name of observer. Age of child.
Date. Sex.
Time since observation was made.

1. *Measurements.* Arms-length; size above elbow; below; Legs-length; size above knee; below. Measure length of limbs from body to tips.

2. *Arms.* Are fingers bent waking; sleeping; clenched waking; sleeping? Are wrists bent; elbows; shoulders? Do arms lie toward front; side? Are movements of arms toward front; side?

3. *Chest.* Does chest grow flat; deep front to back? Do shoulders grow apart; together; high; low; square; sloping? Do shoulder blades grow apart; together?

4. *Legs.* As child lies on its back are legs bent at hips; knees; ankles? Is the sole of foot turned inward; outward? Are feet turned up; down? Position of toes—bent $\begin{cases} \text{up;} \\ \text{down;} \end{cases}$ straight; used as fingers? Motion of legs front; side?

5. Describe first efforts to sit up; (a) how propped up; (b) in what direction is the body most apt to tip over; (c) does the child reach best front or sideways?

6. Describe the process of getting the head upright or balanced on the neck; its rolling off; learning to save the head from bumping when it tips over, saving a bump by hands and arms.

7. Describe early uses of leg and feet that anticipates standing and walking; as rhythmic moving, kicking, pushing feet against a vertical surface.

8. *Creeping.* (a) First efforts to turn over on the belly, to get head up; (b)to prop up front part of body with hands; describe any and every kind of creeping or locomotion before the upright position; (c) writhing along worm-like; (d) hitching in sitting position with one or both feet or alternately; (e) getting and going on hands and toes, elbows and feet, hands and knees, knees and elbows; (f) in progression how do the limbs act, one side together as in rocking limbs at opposite corners of the body together, or in what order, using the following

ra
ll
la
rl

e. g., to signify first the right arm, the left leg, the left arm, and last, the right leg. If ra and ll act simultaneously, place them on the same line.

9. Describe exceptional modes of progress fully, *e. g.*, rolling, going backwards, on one side, swimming movements, etc.

10. How do children first learn to go up and down stairs, get off of a bed, a chair, and any other things involving change of verticality of body.

11. First efforts to stand, in detail; (a) how made, beside or holding to what; (b) conscious or unconscious; (c) what effects on breath, gesture, feeling, etc., of first successful effort; (d) effect of falls.

12. *First steps.* (a) Are they beside walls or how; (b) first steps alone and unsupported, conscious or unconscious; (c) after the first step, and confidence is acquired do the children you know tend to walk too much; (d) effects and dangers of fatigue; (e) of illness; (f) is there a marked increase in size and fullness of legs at this time; (g) what new propensities as that to run away, more use of hands; (h) is there danger of prematurity or postmaturity in walking, should adults help? Why? Why not?

13. *Reversion.* When does child revert to creeping after he has learned to walk; when fatigued; in a hurry; excited; after sickness; after fall? Why? Revert to early manner of creeping; later?

Miscellaneous. (a) Does the spine hollow to co-operate, as angle at hip, straighten out; (b) give illustrations of children's propensity to climb; (c) describe increasing power of balance, power to stand on one foot, age at first jump, run, hop. (d) have you noticed any changes in health, appetite, circulation, temper, spirits or anything else your thoughts might be connected, as cause or result of learning to walk, sit, or any other stages.

Please write out fully any peculiarities the child may have.

Send returns to

G. STANLEY HALL,
or A. W. TRETTIEN.

CLARK UNIVERSITY,
Worcester, Mass., Jan. 26, 1900.

I. The measurements under number one were made by the writer under as nearly uniform conditions as possible. Although the number of measurements of individual children was limited, the extremes appear, so that in general they give an index of growth.

The figures given here are the general averages and extremes, representing corresponding measurements of the arm and leg. In each case the measurement of the arm is represented by 100.

Average of measurements of males at birth.

Length of arm and leg,	100 : 134.
Circumference of limbs above knee and elbow joints,	100 : 146.5
Circumference of limbs below knee and elbow joints,	100 : 115.

Average of measurements of females at birth.

Length of arm and leg,	100 : 124.
Circumference of limbs above knee and elbow joints,	100 : 143.5
Circumference of limbs below knee and elbow joints,	100 : 114.5

Extremes in measurements of the length of limbs.

Males at birth.		Females at birth.	
Shortest,	100 : 105.	Shortest,	100 : 116.6
Longest,	100 : 150.	Longest,	100 : 137.

The tables of the Anthropometric Committee show that males at birth are a little taller and heavier than females, it also shows that there are greater extremes among males than among females. The figures presented here clearly show the same development with regard to extremities. Males at birth average a greater length, their lower extremities are proportionately longer, but they also present greater extremes.

II. *Arms.* The returns represent observations upon 182 infants; 93 males and 89 females. The results may be tabulated as followed, expressed in per centum.

Fingers.	Males.	Females.	Total Average.
Clenched	83	87	85
Bent	12	4	8
Straight	5	9	7

Wrists—Of the 109 returns, 51 were observations of males and 58 females.

Bent	69	65	67
Straight	31	35	33

Elbows—110 observations; 53 males, 57 females.

Bent	100	96	98
Straight	000	4	2

Shoulders—58 observations; 27 males, 31 females.

Bent	66	68	67
Straight	34	32	33

Arms—98 observations; 47 males, 51 females.

Lay front	98	92	95
Side	2	8	5

The returns of Number 2 show that the arms lay forward from the shoulder, the movements are toward the front in 97% of the 96 observations recorded, only 3% found it difficult to move toward the front and easier toward the side. The elbows and fingers are bent in a large majority of cases; of the 110 observations made, there were found four whose elbows were straight and these were all females. In the case of the wrist there is a difference, 67% of the 109 observations made show the wrist to be bent. Thus the arm and hand tend to retain the prenatal position for some months after birth. This is especially noticeable while the infant is asleep and the limbs assume the position which is most natural to its organization.

The arms are often folded over the chest as they were before birth.

The hand at this time furnishes an interesting study of reflex action. The fingers close firmly on any object placed in the palm of the hand. Miss Shinn noticed that an object placed in the hand was seized and carried to the mouth long before purposive movements had developed. The spontaneous movements are almost constant in some children when awake and in others when asleep. They occur as slow and apparently irregular with alternating periods of rest when the movement ceases or is inhibited by some other form of movement. Dr. Francis Warner[1] observed that the movement of the fingers may be temporarily arrested by a bright object before the eyes or a sudden sound; this arrest, after many repetitions, may be followed by a new series of movements occurring upon less and less stimulation and with increasing quickness and accuracy as time goes on.

An interesting chart has been prepared by Dr. Warner tracing these irregular spontaneous movements of an infant's hand for fifteen minutes when 9 days old. The chart also shows the inhibition of these movements by sight and sound. Miss Shinn[2] observes that while the spontaneous movements may be inhibited by co-ordinated movements from the first to the third month after birth when the child is awake, they may persist in sleep for several years.

Dr. Mumford[3] has carefully studied the development of the independent action of the thumb and the power of opposing it to the rest of the hand. During the early weeks the thumb appears to be a quite useless member, the hand ignores it in its grasping. Small objects are held between the fingers or between the fingers and the palm with the thumb either turned in with the object or extending outside. Only after two or three months does the thumb reverse to oppose the hand. Dr. Preyer found this development appearing the 12th week, Miss Shinn the 9th week and Dr. Mumford the 14th week. With the fuller development of the thumb appears the searching and investigating movements of the index finger. The finger is pointed at objects or carried in advance of the hand as a scout sent out to explore a new and strange environment.

1. Fingers.

1. F., 4 wks. She kept her fingers clenched both awake and asleep, but more especially while asleep.

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[1] Journal of Mental Science, Vol. XXXV, No. CXLIX. New Series, No. 113, p. 37.

[2] Shinn: Notes on Development of a Child, Plates III and IV.

[3] Brain, Vol. XX, p. 303.

2. M., 3 wks. His fingers were clenched both wehn awake and asleep.
3. M., 2 wks. When awake his fingers were bent, but when asleep his fingers were clenched.
4. M., 2 wks. The fingers of the baby are not clenched, but only a little bent when awake, but when asleep they are clenched tight.
5. M., 5 mos. The fingers are bent and in constant motion when awake and asleep.
6. F., 2½ mos. Kept her hands closed when awake and open when asleep.
7. M., 2 wks. The fingers were clenched when awake but clenched tighter when asleep.
8. M., 3 wks. When awake the fingers are not clenched, when asleep the fingers are clenched.
9. F., 3¼ mos. The fingers are bent loosely, and the fourth finger sticks out straight.
10. M., 4 wks. During the early weeks of life the fingers are clenched when awake and bent when asleep.
11. M., 4 days. Fingers were clenched when asleep and bent when awake.
12. M., 3 wks. If disturbed in sleep the little fingers would spread out like a fan.
13. F., 1 wk. The fingers are slightly turned at the tips.
14. M., 6 wks. When awake the fingers are moving inward, he puts his hand out straight with his fingers as far apart as he can. When asleep the fingers are bent.
15. F., 8 wks. The baby's fingers are generally tightly closed when awake, except when in pain they are clenched.
16. M., 4 wks. The fingers are clenched so tightly that the nurse must pry them open in order to wash the palm.

2. Arms.

1. F., 4 wks. She would always keep her elbow bent and would seldom attempt to hold the arm straight.
2. M., 2 wks. The wrists are but slightly bent; the elbow is considerably bent.
3. M., 5 mos. The wrists are bent inward.
4. M., 3 wks. The wrists and elbows are bent.
5. F., 3¼ mos. The arms are bent from the elbows when asleep and crossed over the breast so that the right hand is below the left.
6. M., 3 wks. The movements are toward the front usually, the little hands double up when resting on the chest.
7. F., 1 wk. The little hands are clasped over its chest, if it has its little shawl on it will also clasp it in its arms.
8. m., 6 wks. When asleep the arms are folded across the chest so that the left hand is near the mouth and the right a little below it.

III. Chest.

The movements of the infant's arms are limited to the plains extending forward from the body. The shoulder-joint is most free, the elbows and wrists are quite rigid, and it is only gradually that the infant acquires the ability to move its arms sidewise or to move its joint freely.

The answer to these conditions will appear in part from a study of the chest and its development. A study of the returns

shows that the growth of the chest continues along two lines—in depth and sideways.

In the prenatal stage the position of the arms is across the chest, the shoulders are brought forward, the shoulder-blades separated, giving the whole body a round appearance. As growth continues after birth the tendency is to push out along the line of least resistance, the sternum is cartilaginous, consequently the chest walls are pushed forward and a little side of the median line, the body grows in depth from front back. This development carries the shoulders back and up or back and down, the shoulder-blades approach one another, the back becomes straight and the shoulders square or sloping.

One observer says—that "at first the shoulders grew up, then after 3 mos. they gradually grew sloping." Another says—"Florence's shoulders grew very square; the shoulder-blades grew so close together that the whole body was pulled back." This is the natural course assumed by the body as it changes its position from the curved or stooping attitude to the erect. An observer who noticed the fact and not the cause, says: "The shoulder-blades grow together, for as the baby learns to straighten up, she throws her shoulders back." Another manner of growth is that in which the chest grows in width and apparently becomes flat, in this case the shoulders and shoulder-blades are crowded apart. The back keeps pace with the chest. Out of 79 observations made 37% of males and 53% of females developed sideways, their chests becoming flat and broad. With this development the shoulder is brought back, so that a wider range of movement becomes possible, and one great advancement toward adult movements is made.

1. Arm Movements.

1. F., 4 wks. All her movements were more toward the front of the body, and only gradually off to the side.
2. M., 3 wks. The arms move up in front first.
3. F., 3 mos. Her arms tend to lie more to the front of the body and the arms move forward.
4. M., 4 wks. Movements of his arms were in front of the body when lying on my lap.
5. M. The child does not make movements toward the sides until about 9 months old.
6. F., 5 wks. If the child wishes to reach sidewise from its body it will turn its body to face the object and then extend its hand.

2. Chest.

1. F., 3 mos. When Magdelena was small her chest was very deep, but after she was about 3 mos. old her chest seemed full.
2. M., 6 mos. The baby seems to be growing thicker through, the shoulders are growing more square.
3. F., 3¼ mos. The chest grows from front to back in depth. Her shoulders grow square and high.
4. F., Birth. The chest grows sideways, the child grows broader.

5. M., 3 wks. The chest develops sideways, the shoulders grow apart.

6. M. The early year of Herbert's life his chest grew in depth; his shoulders grew apart; his shoulder-blades grew together; and his shoulders grew low and sloping.

IV. Leg.

The prenatal position of the feet is maintained after birth for some weeks, up to the time the limbs prepare for the creeping and walking stages. The legs are bent at the hip-joint bringing them forward. The knees are bent and usually turned out a little; the feet cross, with the right foot laid over the left, and are turned up with the soles toward the median line. The toes are usually curled under toward the sole of the foot; occasionally one is found where the toes spread apart and extend out straight from the foot. Often the great toe is found to be far separated from the other toes, with the tendency to oppose it to the sole of the foot. The greatest freedom of movement at first occurs at the the hip-joints, with less at the knees and little at the ankle-joints. The movements of the legs, as of the arms are front and back, rarely toward the side. It is a very frequent occurrence to use the feet as hands in seizing objects and carrying them forward to the hands and mouth, the storehouse of all captured prizes. Several instances from observers will illustrate this. One speaks of the spontaneous movements of the opening and closing of the toes, similar to the movements of the fingers, when the child was awake and asleep. Another states that the toes would seize and hold a pencil or other object of proper size and hold it so tight that it was difficult to remove it, or it would seize and hold the edge of its shirt as if it were using its fingers. Another child would work its way toward the foot of its couch until its feet touched the perpendicular round sticks at the foot of the crib, the foot would then attempt to grasp the sticks, finding them too large for its grasp it would move its foot from one to the other until it came to the central wire which it could encircle and this it seized and held firmly. Another observer states a peculiar tendency in a child 7 months old,—if the child saw an object she wanted, which could not be reached with her hands she would reach for it with her foot, if successful, she pulled it along with her foot until it was near enough to reach it with her hand. It is not necessary to multiply instances any further to remind one of the cunning devices of the little anthropoids in the menageries reaching for their peanuts.

1. M., 10 mos. When laid on back the feet are crossed and turned upward. The motion of the legs is toward front, side movement was developed at about the 9th month. The child was called "Little Turk," from the position of his legs.

2. M. 5½ mos. When Robert lies on his back his legs are bent and

he immediately raises them forward to seize with both hands, and carries them to his mouth. The knee is bent, and with the sole of the foot is bent inward; the ankles are bent out; the foot is bent downward; the toes are curled under. The motion of the legs is forward. He grasps the stockings with his toes.

3. M., 9 wks. The great toe is separated from the others and is moved more.

4. F., 2½ mos. When the child lies on its back the legs are curved and crossed. They are not mobile, and the mother has hard work to pull them straight. The toes are spread. The movement of the legs is forward at first.

5. M., 2 mos. The legs are curved inward; the feet are turned downward; the toes are close together and turned backward. The motion of the legs is decidedly toward the front.

6. F., 3 mos. When lying on her back the legs are bent at the knee and at the ankle. The soles of the feet are bent inward and the feet are turned upward. The toes are spread apart.

Treatment of Infants among Primitive Peoples.

We have now arrived at one of the most interesting points in the process of development of the child, that is from the time when the head is balanced upon the summit of the spine and the body begins to rise into a sitting position, to the time that the child takes its first steps. This period is important, for the ignorance of parents and nurses have caused many a child to spend its life a poor deformed creature at the mercy of society. To know whether it is normal for a child to develop the power of co-ordination and thus to sit or stand alone, to understand the childish actions, whether in creeping or walking, is a lesson which has taken the human race a long time to learn; and certain parts of it, even in civilized lands, have not yet learned the lesson.

It will not be amiss here to cite several instances of practices among some of the primitive as well as customs among civilized people to which infants are subjected. Dr. Ploss[1] has said that "the manner of treatment of the child is a very accurate standard of the stage of civilization of a people." No truer words than these were ever spoken. Superstition and ignorance are the two mistresses who hold the keys which unlock the treasure house and set truth free. They are also the stumbling blocks in the way of progress for individuals and races.

Primitive as well as civilized people have looked upon infant development as an unnatural process. They have had an entirely false conception of the natural development of the body and its various organs and their functioning at a proper time, if not interfered with. If left to nature, according to these people, the body would not assume a proper attitude, therefore they seek to aid the natural growth by mechanical treatment of body and limbs to bring about their ideal forms, and it is need-

[1] Das Kind, Vol. II, p. 50.

less to say that such means operate directly against the end sought.

Dr. Ploss[1] tell us that the Wahumba and their allies, the Wakuafi in East Africa, have a practice of binding the lower part of the leg of the infant, from the ankle to the knee, with a bandage which remains until the infant grows strong enough to raise its body and sit up. By this compression they seek to interfere with the development of the calf of the leg, which, according to their notion, interferes with fast and continuous walking. The Maori women of New Zealand daily put all joints through a process of bending, the fingers are drawn out and the limbs stretched to make them limber. Certain tribes of Australia exercise the limbs of the new-born in the following manner:— A roll of muka is tied quite tight around the knee of the child in order to give it straight limbs, its arms and legs are drawn out daily, while the hands and fingers are bound firmly to keep them in the proper position. The soft flesh is often so compressed underneath the bandage that it is forced out at the sides. These people place much significance upon this shaping of the body, and the mother is considered as neglecting the sacred duty toward her child, if she does not, by artificial means, have the calf of its leg conform to the statutory provisions.

It is the custom of the Kalmückin to place a definitely formed wedge between the legs of the child in order to bend them according to the prescribed custom that they may be the more properly adjusted for riding. Certain Armenian people, after the 15th day of an infant's birth, thoroughly stretch the shoulders daily, pull out the legs and arms, press each muscle and joint, raise the head and stretch the neck to give it its proper length, or the child is suspended by its feet and allowed to swing back and forth several times like a pendulum, then it is turned about end for end and the process repeated. The Russians press every muscle and member of the body at birth, on the second day the infant is rubbed and whipped with a bundle of birch twigs, then it is snatched up quickly by the feet in order to properly adjust the members of the body.

Even the Germans had an early custom which is practiced in some sections of the country to-day, where the pressing and stretching process was employed to beautify the body. In modern times in Europe and America, the horse-collar, a sewing-machine cover and other means are employed to aid the infant in sitting up, or it is tied in a chair and allowed to remain so that the weight of the head and trunk becomes too great to be supported by the soft and growing bones. Or children are encouraged to walk by putting them into a walking chair before the

[1] Ploss: Das Kind, Vol. I, p. 334.

limbs can support the weight of the body, thus endangering their normal development. Our age of civilization is not yet freed from the results and methods of infant torture which were inflicted upon it for both their artistic effect and also to hasten the child's normal development. From these illustrations we see that there was lacking in primitive people and even among some of the civilized people to-day a proper appreciation of the normal development of the child. And one of the greatest drawbacks of a proper appreciation is a lack of precise facts concerning the healthy child.

During the early months some people believe that the child must learn to "sit up," and consequently they carry it erect on their arms during the first weeks of its life, later it is placed in an erect attitude upon the floor or in a chair. The chair was used early in history as a means of teaching the child to sit. The early Romans used it; it was found in the early Middle Ages throughout Europe. Travellers[1] to different parts have found the chair among natives. In Queen Charlotte's Island, voyagers found the native women using a small chair made of three pieces of bark fastened in a convenient manner. In this chair the child was placed, after it was rolled in the skin of a wild beast and fastened securely. Here the little thing was fed and rocked to sleep. Among the Esquimos on the Yukon, Mr. Whymper saw small chairs made of birch bark, in these a mossy seat was made and the little fellow was securely tied so that the mother could carry the chair and child wherever she pleased. The Chinese and Dutch have gone a step further and have combined the sitting with walking and have placed the child in a chair with rollers so that as the little one begins to walk it can push its chair with it, they have also added a table with a complete outfit of playthings and even school work is here introduced.

The chair, however, is an article not yet known among many primitive peoples. They let the child wallow upon the ground and let it learn according to its own unfolding strength and by its own intuition and observation. This is not only true of the primitive people but also of many of the Oriental who sit upon low cushions or squat upon the ground with their feet under them. And it has been observed that when the adults of a race assume these postures in sitting, the children learn the same by imitation. Examples may be cited upon this point from travellers' records. Thus, the Motu, a tribe in New Guinea, have a custom in which the men, in sitting, usually assume the squatting posture placing the soles of their feet firmly upon the ground and rest the buttock upon the heels. The women and children

[1] Ploss: Das Kind, Vol. II.

usually sit down upon the ground with their legs extending before them. The Popuas and Malays, the Negrites and Filipinos, assume similar positions when resting. As the children naturally follow and imitate the mothers earlier than the fathers they sit as the mothers do. At first on the mother's knees resting their backs against her body, then with increasing strength they assume the positions alone.

Locomotion of Infants of Primitive People.

Travellers have also noticed a similar peculiarity in the manner of locomotion of the children of certain tribes which are characteristic. The Arabian children as well as those of some of the tribes of Africa have a different manner of creeping from the European children. Instead of creeping on their hands and knees as the little Anglo-Saxon is wont to do, they sit up and slide along by hitching. Dr. Livingstone says in his "Last Trip through Central Africa," "The Manyuema children do not creep like European children upon their hands and knees, but begin their locomotion by placing one foot forward and rest upon the other knee, usually they employ both feet and both hands, but never both knees. The Arabian children employ the same means, they move along on both feet and assist in pushing with both hands." The children of these primitive people learn to walk much earlier than do the European and American children. Dr. Gräffe observed on the Island of Samoa that children of 9 and 10 months followed their mothers with tottering steps.

The usual manner of infant locomotion among primitive people, and some Oriental, is one of several rather exceptional means employed by the children of higher civilization. Anthropology has not yet answered the cause of this difference. Whether it is due to physical structure of the body or to mental characteristics and customs. Though students are inclined to accept the latter view.

Mr. R. W. Shufeldt[1] describes the acts of an infant about 10 months old which he saw while visiting the Navajos, an indian tribe inhabiting parts of New Mexico. He had been about the huts trying to secure pictures with a camera when he saw in a path, leading from one hut to another, an infant toddling along which he believed about 10 months old. The little fellow came down the path to about 30 feet from where Mr. Shufeldt had planted his camera in readiness for this little victim. Seeing the situation, the child very cautiously left the path and was in a moment behind a sage-brush growing along side the path. From this position he peered through the leafless twigs. Mr.

[1] Nature, Vol. XXXV, 1887.

Shufeldt then tried to focus his instrument anew; while his head was concealed for a moment, the little lad ran to the next brush about 10 feet distance toward the hut he was approaching and from there, crouched down and stared like a young lynx. At this Mr. Shufeldt took his instrument and approached him in this place, but upon arising he had scampered to the next brush. Now becoming desperate, lest he should lose his picture, Mr. Shufeldt ran to the place of concealment and pointed his camera three feet from the little fellow's face. At this last resort the child stood perfectly erect and gave for the first time vent to his infantile bawl and made a desperate break for the final point of his destination as there was nothing else left for him to do. This ability and cunning was displayed by a child 10 months old.

Psychological Aspect of Spontaneous and Voluntary Movements of Infants.

During the early months of the child's life we accordingly see important changes taking place, the spontaneous movements are very gradually disappearing, and in their place appear the conscious reactions, even apparently shut voluntary efforts. This is the period of gradual transition from the racial to the individual experience. The child learns to carry its hand to its mouth, the movements of the arms and legs which were so jerky and vague assume a more rhythmic and controlled character. What changes are taking place in this transition from the purposeless to the volitional movements? Several theories have been advanced in explanation of this step. Ribot considers the acquired movements, like walking, inherited and defines inherited as something that was at some time acquired but since has become fixed and rendered organic by numerous repetitions. It is organic memory. Spaulding[1] maintained that "the progress of the infant is but the unfolding of inherited powers." C. Lloyd Morgan[2] in answer to this says, "Spaulding went too far. Such unfolding there is, but it is under the guidance of individual experience. The regular flexions and extensions of the legs, 'which appear even months before the first successful attempts to walk, when the child, held upright on the floor, is pushed forward,' are instinctive, as Prof. Preyer points out, and as Prof. Mark Baldwin has shown. But under normal circumstances the walking of the child is not solely an instinctive activity, acquisition largely co-operates. It is the joint product of instinct and acquisition." Mr. Bain[3] sums

[1] Nature, Vol. XII, pp. 507, 508.
[2] Habit and Instinct, 1896, p. 106.
[3] The Senses and Intellect, 4th Ed., p. 281.

up his view when he says—"the instinctive character of locomotion, so obvious in the inferior animals, is less apparent in ourselves, seeing that the power of walking is not possessed by us until about a year after birth. Nevertheless, there are certain strong presumptions in favor of an original endowment entering into our aptitude for locomotion." The Spencer-Bain theory attempts an explanation along the line of the current biological adaptation. As Prof. Baldwin[1] has summarized the theory—"the organism is endowed with spontaneous movements, a certain spontaneity of action which must be assumed. Certain of these spontaneous movements happen by 'lucky chance' to succeed in bringing the organism into some special adjustment, better exposed, better protection, easier function, etc.; these movements are accompanied by pleasure. The pleasure lingers in the consciousness of the creature in connection with the memory of the particular movement which brought it; and the memory of the pleasure serves to incite the creature to execute the same movements again, whenever the external conditions present themselves. The repetition thus secured serves to fix the new adjustment as a permanent acquisition on the part of the organism." Here we have the assumption of consciousness with pleasure and pain and the power of the creature to associate the stimulus which produced it with the movement which will carry it toward or from the object which produced the sensation. And Bain adds—"Here is assumed the law of pleasure and pain. Pleasure is accompanied by heightened nervous energy, which nervous energy finds its way to the lines of communication that have been opened up by the lucky coincidence." Prof. Baldwin[1] now goes a step farther by what he calls the "Motor Excess," and says that pleasure and pain can be agents of accommodation and development only if the one, pleasure, carries with it the phenomenon of 'motor excess,' the other, pain, the reverse. Then he asks why certain movements which are accidentally more adaptive than others give pleasure. And his answer is, that the movement in itself is not pleasurable, but it is only pleasurable in so far as it gets something for the organism. Something which ministers to its life, that gives it pleasure.

This view assumes, then, that "the organism begins with a susceptibility to certain organic stimulations—food, oxygen, etc.; these when present give pleasure, the pleasure is, physiologically considered, a heightened vitality in the central nuclear processes; this heightened, central vitality issues in a motor excess discharge; from the resulting abundant and varied movements of this excess discharge those are selected which bring

[1] Mental Development, p. 181.
[1] *Ibid*, p. 189.

more of these vital stimulations again; and these finally keep up the vitality of the organism, and by the repeated excess movements, provide for constantly progressive adaptations."

This summary gives us the evolutionary view of movements. Biologically speaking, movement is controlled by the "principle of auto-differentiation." The organism possesses the power of developing in a definite direction and into a definite end product. This power is potentially inherent within the smallest germ. Each living organism carries with it as an essential attribute movement. And movement which is a concomitant of the development of the organ. The so-called "spontaneous movements" of the lower creatures and the human infant are organic. As the nervous system develops, forming co-ordinations of the different centers and the movements become more rhythmic and less spasmodic, as consciousness unfolds, these movements, as any other stimuli produce certain psychic states which can be reproduced at will and the once spontaneous movement becomes voluntary. Observations show also that a successful reproduction of the co-ordinated movements in the infant produce pleasure and it wills to repeat a movement again and again. There is, then, in the child a physiological development as well as a psychic unfolding which bridges the racial and individual experience.

Let us observe the facts as they appear.

Attempts of the Infant to Rise Up.

The first tendency in the child to rise into a sitting posture is manifested in its struggling when it is put down into its crib, after it has been carried in the arms, during the early months of life. There is an attempt to raise the head. This is due to the fact that the primitive segments of the cervical region of the spinal column develop first and precede in growth the remaining parts. The upper parts of the entire body develop earlier and consequently function earlier than the lower parts throughout the early years. The time when the infant can first raise the head varies with different individuals; some are able to hold it erect, and even balance it, at birth, but in general it is about at the the age of two or three months when the head is raised and about four or five months before the muscles are co-ordinated which maintain it erect and keep it from vascillating.

The head of the infant which rolls off the shoulder may fall in any direction; most often, however, it falls forward upon the thorax and rolls toward the side. The muscles of the neck at birth are very small, as has been indicated in the foregoing table, since the neck increases nine times its size at birth.

MOVEMENTS OF THE HEAD.

1. M., 2 mos. Head rolled off in every direction.
2. F., 1 mo. Head falls side and back.
3. F., 3 mos. Head rolls toward front and then toward side.
4. F., 3 mos. Head rolls toward one side.
5. M., birth. Lifted his head without apparent effort on the day of his birth. Seemed able to control the movements of his head from the first.
6. M., 3 days. Tried to raise head but failed. Head fell toward front.
7. M., 1 mo. Head rolled off front, then sideways.

With the ability to raise and balance the head, the muscles of the back, chest and abdomen develop so that the infant may some day surprise its mother or nurse by suddenly stiffening its neck by straining its back and seizing firmly the side of the crib and pulling its body into a sitting posture, or rising on its knees while in its bath. Very frequently this first successful rise is the result of a special and strong stimulus, such as a fit of crying, hearing an unfamiliar sound, etc., and when its feeble efforts are rewarded by success a smile of joy passes over the face of the little one.

Many children are, however, given the suggestion to rise in a sitting position by grasping a parent's extended fingers and are then pulled erect. Miss Shinn observed that as early as the seventh week, when the mother held the hands of the child in wiping her after her bath, there were slight muscular contractions, though with no intent to pull herself up, as her mother had tried to develop it by giving her a finger and pulling. When the child was three months old, she succeeded in rising up by the aid of the fingers, but immediately tipped over sideways. After that she tried twenty-five times in succession to lift herself by her abdominal muscles, but could only lift her head and shoulders. She was then stopped as she showed discouragement. The common method employed by children in sitting up when placed upon the floor on their backs where they cannot pull themselves up by their hands is—by first rolling over upon the stomach; they then rise upon the hands and knees, turn sidewise in a half reclining, half sitting position, supporting the body with one hand and finally raise the trunk into a sitting position. A rather peculiar manner is seen in Miss Shinn's niece. The child first rose to her hands and knees, then separated the knees and lifted herself backward into a sitting position, landing the child with its legs spread wide before turning out at each knee in a right angle. This exceptional sitting position was invariably assumed. The usual position for children is the simian—in which the legs are extended forward with the soles turned toward each other. After such exercises, repeated daily, children soon learn the

possibility of sitting erect and are not content to lie down when not asleep.

1. F., 4 mos. Baby could not raise itself when lying down. One day it was angry because it wanted to be taken from its cradle. It stiffened its neck, seemed to exert all the muscles of its chest and abdomen, and after falling back two or three times succeeded in raising its body into a sitting position.
2. F., 2 mos. When Mary first began to sit up she would stiffen her neck and then her back and try to balance herself in that manner.
3. M., 3 mos. First raised its head like a turtle.
4. M., 4 mos. Baby first raised its head again and again until it could raise its head and back.
5. M., 4 mos. Tried to sit up when lying on its back, but could only succeed in raising the head from the pillow. After repeated efforts it got over on its side, then it pushed itself up and rested on its arms in a half reclining position.
6. F., 1 mo. Helen tried to sit up by first taking hold of the side of the crib and then tried to pull herself up.
7. F., 2 yrs. Tried to sit up by raising her head up as far as possible without using her hands.
8. F., 2 mos. This child while lying on its back would raise its feet and head, the head in its effort to rise would bob from side to side.
9. F., 4 mos. In trying to sit up the child will first raise its head, then its back, followed by frantic efforts to rise farther.
10. M., 2 mos. In trying to sit up the baby would first raise its head, then try to pull up the body with all its might.
11. F., 1½ mos. I have seen Mary, when lying in her crib or carriage, take hold of it with her hands and try to pull herself up.
12. M. The baby was lying in its bed; it took hold of the side with its hands and succeeded in raising its head up. It would then lie back and rest awhile and soon repeat the process.

After the muscles of the neck and trunk have developed sufficiently to raise the head, the child must still learn to coordinate their movements and tension, to balance it upon the trunk. The head at first bobs and jerks from side to side, forward and back, under which conditions the infant manifests not a little interest mingled with anxiety and determination. Unexpectedly, however, the head takes a sudden roll forward and sidewise through a great part of the arc, regardless of consequences. There are as yet no compensation movements to protect it. The only way in which nature has favored the infant against serious bumps at this time is in allowing the muscles which raise the head to precede the muscles of the trunk in development. The infant makes no attempt to save its head from injury until later when it can raise its body. Then after repeated experiences are the movements of falling and the sudden stop associated, and compensation movements manifest themselves. From the returns and observations, it appears that there are three different means employed of saving the head from bumps. First, a twitching of the eye; second, turning the head in another direction to oppose the fall; and third, putting out the hand to secure the head or intervene between

it and the obstacle, thereby making a softer surface to strike. The last seems to be by far the most common.

1. M., 5 mos. Baby does'n't know enough to keep his head from bumping, just falls over and bumps.
2. F., 8 mos. First made no attempt to save the head; later it used the hands to shield the head and tried to fall on the hands.
3. M., 2 mos. If the head rolled off, or even if you lowered him quickly, he would shut his eyes and throw his hands forward to save himself.
4. M., 7 mos. Put his hand on surface against which his head might fall to save it from the bump.
5. F., 6 mos. The child holds on to the pillow with the hands to save its head from bumps.
6. F., 3 mos. After a few bumps she would put up her hand.
7. M., 4 mos. Simply lets the head bump.

In the same manner, it requires several weeks for the muscles of the trunk to develop sufficiently to balance the body in the sitting posture.

The returns show that the body falls over forward and toward either side, but usually toward the front and toward the right side. This fact shows that the legs at this time already play a little part in supporting the body as braces. In case the body falls toward the right side and a little forward we can probably see the influence of the prenatal position of the right leg, which is often raised and extended across the body, so that the position of the left leg upon the floor more firmly than the right may throw the body as it falls forward toward the right. The movements of the hand are almost entirely directed forward. The baby reaches forward, in case there is an object at the side which it wants, the body is turned to face the object, then extends its hand. In case an attempt to reach sideways is made the body is sure to fall in that direction. This shows conclusively that the co-ordination of movements takes place along a certain line and is subject to a law of development which is much influenced by prenatal conditions. At about the seventh to the ninth month the normal child has sufficient control of its muscles to enable it to sit erect without being held or fear of falling over. It cannot yet move nor does it attempt to do so. Dr. Rotch[1] says of this period of child growth "that as long as the infant can be made happy in the prone position, whether in the nursery or carriage, it is better for it to be kept in this position. When it begins to sit up during the first year the back should be carefully supported by a pillow." The hospital reports show that the manner of carrying children, as well as the means employed in teaching them to sit up, results in serious spinal deformities, as the weak, undeveloped muscles have a tendency to allow the formation of a lateral and posterior curvature.

[1] Dr. Rotch: Pediatrics.

1. F., 2 yrs. The baby would fall toward the front.
2. M., 9½ mos. The baby would fall toward the front and side, but more frequently toward the right side.
3. M., 5 mos. The child was propped up in a horse collar on the floor, it then would fall forward on its face.
4. M., 1 mo. The child was propped up with pillows, he would then try to lift his head and look around, but his head would roll off sideways. He falls toward the front and always when about to go puts out his hands and closes his eyes.
5. F., 6 mos. The baby was most apt to tip over toward the left side.
6. F., 4 mos. Mabel was taught to sit up alone by being put in a sewing machine top with pillows and blankets around her.
7. M., 2 mos. Baby was most liable to fall toward the right side.
8. M., 1 mo. The baby falls forward and almost always toward the right.

Rolling Over and Creeping.

Dr. Ploss says "the child will learn to walk by its own efforts, if, at the time it feels the increasing strength of its muscles, it is allowed to exercise its limbs upon the floor." At first very feebly it sits erect, then follow its desires to change position and reach for or move toward distant objects by getting upon its hands and knees and creeping or hitchiug along with its feet to the desired spot. Creeping or hitching is then a necessary step to walking.

The study of creeping as it appears in this chapter is based upon the returns of observations made upon 150 different children representing those of American, English, German and Irish parentage. As creeping and walking are entirely voluntary movements the individuality of the child appears very markedly.

The returns show that early in life, sometimes by the third month, the reflexes of the legs become more or less co-ordinated into differentiated rhythmic movements, which are simply alternating leg movements. They may be forward and backward or the reverse, rarely sideways. These rhythmic kicks may very early be stimulated by touching the soles of the feet to a coverlet or floor. Some children will amuse themselves for half an hour by simply repeating these alternating movements. Prof. Baldwin noticed in one of his children that alternating movements were backward but that creeping had a tendency to correct them.

At seven months the well, strong child will enjoy standing on its feet if supported. It will straighten its legs and press its feet against a resisting surface. It will jump and kick vigorously.

M., 10 mos. Baby would push its feet against the crib or pound its feet on the floor when lying down with much enjoyment.

M., 7 mos. When placed so that his feet could touch a flat surface, he would put down his feet as if trying to walk. Would also push his feet against a person's lap in standing up.

F., 3 mos. Pushed with her feet against one's body.

M., 4-6 mos. Lay on the floor on his back and kicked for 20 minutes with much apparent enjoyment.

F., 9 mos. In trying to stand, she would jump up and down on her mother's lap, and place one foot on the top of the other.

M., 6 mos. As soon as he felt his toes touching he would dance up and down. His little back would stiffen and his leg would straighten out.

The manner of turning over on the belly, preparatory to creeping, varies with different children. Some thoroughly enjoy lying on the abdomen, while others do not, one observer states that she could always stop a child from crying by placing it, when very young, across her knees. This position may have relieved a disturbed stomach or other visceral ailment. Other children may roll over accidentally and find that they can apply their hands to better advantage than when lying on their backs. Other children do not enjoy lying in a prone position, especially after they have gained sufficient strength to sit erect. They lean forward, sidewise, and turn part way, half-reclining, half-sitting. By irregular movements they assume a variety of positions. The majority of children, however, will, when placed upon the floor, after they have gained sufficient strength, roll over on the abdomen and pat the floor with the palms of their hands. When this position has been gained, children will soon learn to raise the body with their hands. One observer remarks—"when Eva first attempted to support her body with her hands she would put her little hands flat on the floor and with a great strain try to raise her body. Her first efforts failed; soon she could raise the body, but not sufficiently to straighten her elbows, and after a few moments her strength gave way and the body fell heavily."

The different means employed by children in turning over on the belly vary from the purely accidental to those which appear to be voluntary. Some roll over while trying to reach forward for an object and often manifest extreme surprise at the position, or they cry, perhaps because of the shock. Others roll over upon the side after much wiggling, and then by a sudden movement of the hand or leg roll over, or they may throw one or both legs over, thus carrying the body over upon the side. Still other children turn over from the sitting position. They first turn over on the side then upon the belly. The same method is usually employed by a child which was first successful, no matter how laborious.

Rolling Over on the Abdomen. Raises the head a little and a corresponding movement of the legs—then rolls over with one arm underneath it. After repeated trials this arm was drawn out.

Child was lying on its back, it rolled over upon its side with one arm under it. In its effort to get its hand out it rolled over on its belly. It first placed arms out at full length upon the floor.

M., 10 mos. In making an attempt to roll over he would raise his head and roll over on his side as far as possible and strain as hard as he could. He would, at times, be unsuccessful and cry.

M., 9 mos. When the child reached for something he toppled over, then in trying to get up again he props himself up, and in this manner acquired the habit of creeping.

M., 10. Put one hand on the floor and held one leg still while it threw the other over, carrying the body to the side.

F., 8 mos. When sitting on the floor, she would roll over on her side, then turn over on her belly and kick.

F., 9 mos. Put hands over to one side then turned the body after.

Creeping. From this position of sitting one of the various forms of creeping is easily employed. A study of 150 children (males and females equally divided), shows that 60% crept while of the remaining, 30% moved along by hitching, 7% by rolling, 3% by crawling, swimming, or some other means peculiar to the individual. [1]Fifty % of the creepers moved forward on their hands and knees, moving their limbs on the opposite corners of the body together. [1]Twenty % moved forward on their hands and knees but moved the limbs on the same side of the body at the same time as in pacing. Nine % walked on their hands and feet with the limbs on the opposite corners of the body moving together, except one little girl moved the limbs on the same side together. One little boy planted the feet out aside of the tracks of his hands. Twelve % (7 males and 4 females) walked on their hands and dragged the body and legs, and 6% (3 males and 2 females) crept backwards. One used his hands only in pushing the body back to the desired spot. The remaining 3% had movements which were distinct from any other or combinations of other movements of creeping, such as creeping on the hands and knees, the hands alternating and the knees moving together as in jumping; creeping by the use of both arms and one leg while dragging the other leg; or by the use of only one arm and one leg.

M., 12 mos. In creeping he used first one hand then the other, then drew up both legs together.

This child goes along with one leg out straight behind, creeps on its two hands and one knee.

M., 6 mos. He crept in the ordinary way, using the l. a. and l. l., then r. a. and r. l.

F., 6 mos. Crept on both hands and with right foot, dragging the left.

F., 7 mos. When D— sits on the floor she goes over to the right, raises herself with her right hand, then gets on her hands and knees and creeps around, making a great noise for a small child.

M., 6½ mos. James used to creep in a very peculiar manner. He only used one arm and one leg. He would rest on the other side of the body, but never use those limbs in creeping.

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[1]Boys and girls equally divided

F., 10 mos. D— began creeping at the age of ten months; she moved the r. a. and l. l., then the l. a. and r. l.

F., 10 mos. Lucy first began to creep, then walked on her hands and feet.

F., 6 mos. Walked on hands and toes.

F., 11 mos. The baby got on its stomach and with its two hands endeavored to move along, occasionally kicking slightly with its lower limbs. In moving the limbs acted alternately. One day evidently the child could not creep, in this way, fast enough to suit herself, so she very quickly turned round and by the use of her hands and by kicking her feet she pulled herself backwards.

M. The child is very fat. He does not creep on his hands and knees, but sits square down on the floor and by the aid of his hands slides along.

M., 5 mos. He would put his hands on the floor and then slide his feet out from under him toward the back.

M., 6 mos. To get along on the floor, he would sit on his right leg and rest on his right hand, dragging his left leg after him and using his left hand for propulsion.

M., 6 mos. He pushed himself backward with his hands.

The baby lay on its stomach and used her arms half bent to drag herself along.

M., 9 mos. Little Frank, in trying to move about the room, would place his hands flat on the floor just as far in front of him as he could possibly reach, then bear his weight on them and lift the front part of the body off the floor, then he would give a spring and throw his body forward. His little twin sister, Marjory, would lie almost flat on the floor and wriggle along like a worm, first to one side then to the other, with her hands in front of her which pulled her along.

Hitching. The next most common means of infant locomotion is the so-called hitching. The returns show that 30% of the whole number of children observed progress in this manner. The child does not turn over on its belly but moves in a sitting position. The movement is usually preceded by reaching toward an object desired which tends to carry the upper part of the body forward; this forward movement of the body produces its natural converse, that of drawing the feet toward the body or bracing them upon the floor; this may draw the entire body forward. Some of the variations in hitching are such as sitting perfectly erect and pulling the body forward with both heels; pushing the body along with both heels and sliding the feet forward; sitting on the left hip and using the right leg and left arm to move the body forward; using the right leg and arm to move the body and drag the other leg after; using both feet and both hands, the feet to pull and the hands to push the body; jerking movements of the back which carry the body forward, or simply twisting along in a sitting position without the use of either limbs.

The baby sat upright on the floor and hitched himself along without using his hands. Another baby sat on the floor and used only one side.

F., 9 mos. Little Nannie would sit straight up on the floor and without putting her hands to the floor, work along as fast as a person

would walk. She did not make much effort and her parents often wondered how she could do it.

F., 9 mos. Sadie hitched along using one (right) hand and foot.

F., 12 mos. Child was very backward in creeping and when she did begin she pushed herself along by her hips, first on one side, then on the other.

F., 14 mos. Violet never crept. When 14 months old, she moved around by sitting on the floor and using one leg to help her along over the floor. She put her leg and foot forward and then seemed to steady them and draw her body along.

F., 8 mos. Sat up straight and hitch along. She never crept, but after this stage learned to walk.

F., 9½ mos. Would sit down on the floor and push herself backward, moving a little from one side to the other. Could move faster in this manner than if she had crept.

M., 10 mos. This child would hitch along. It would have its left foot under its right. Its right knee was erect with its hands resting upon it.

Rolling. Rolling is an occasional form of child locomotion. 7% of the whole number observed rolled over and over until they arrived at the place desired. One peculiarity in this rather exceptional manner appears in the apparent deliberation of the child just before setting out as if to decide just what and how to do it, but after several attempts he becomes very proficient in its movements.

Occasionally we find a child which can creep quite well but rather slowly. But if it is in a hurry it will abandon this manner and lie down and roll over and over, thus going much faster. In studying the early creeping and rolling movements of her niece, Miss Shinn thinks that the child's skirts interfered considerably with the attempts to creep which the grandmother had attempted to teach the child but were abandoned in favor of rolling. She then concludes that "without the hampering influence of long skirts and the practice of keeping babies off the floor, this primitive quadrupedal movement would appear much earlier, and play a larger part in infant activities, than it does. If it preceded securely balanced sitting, the less natural and less useful hitching would never appear as a substitute." This conclusion is not warranted by the studies made upon the babies of primitive people who are not hampered by skirts or cold floors, yet they prefer hitching to creeping.

Exceptional Movements. Among the 3% of the exceptional movements are seen the following:— Crawling like a worm upon the belly with the hands and feet close but using them very little; swimming movements, the hands moving at the sides with feet kicking; moving backwards on the buttocks and elbows, the head occasionally striking the floor wearing a bald spot on the back of it; crawling upon the belly using hands and abdominal muscles to throw the body forward with considerable force; wriggling from side to side or forward and back-

ward on the buttocks without the use of the limbs; and attempting to move forward by swimming movements but thereby moving backward. In these returns the movements were recorded according to the sexes, but they distribute themselves about equally, so that it is not necessary to draw a further distinction.

Rolling.

M. This child first moved from place to place by rolling.

F., 9 mos. At the age of nine months Emily started to roll over and over across the floor. She would first raise her hands and feet to give herself a start, then roll anywhere she wished to go.

M., 8 mos. Walton made most progress when he rolled on his right side.

Hopping.

M. Harold went along like a frog. Laying palms of hands on the floor, then with a little jerk of his body would land on his knees. He would then begin again with his hands and repeat the same process. He progressed quite rapidly considering his method.

Swimming.

M., 9 mos. Carlyle creeps in a sort of half swimming manner. He lies on the floor in this position, his arms and legs are partly bent. He pulls himself along by using the arms alternately.

F., 8½ mos. Lies very flat on the floor with upper part of the body raised slightly. Both arms move outward at the same time. She then puts her hands flat on the floor and her legs move alternately. Then she brings the hands forward, the legs move, the hands move outward and so on. She does not get along very well and seems to try to move forward though moves backward instead. The child would simply wriggle and twist irregularly until he came to the object wanted.

M., 10 mos. Holt was sitting on the floor and near him was a chair, on which there was a bright apple. He looked at it a moment then wriggled over to the chair and taking hold of round by round he drew himself up.

Climbing. Climbing is one of the early impulses of children. Indeed, some of them manifest this desire as soon as they begin to creep. The desire to climb seems to arise in a desire to explore every available spot and practice every known movement. As arms and hands precede the legs in functional development, children may be seen pulling their bodies up alongside a chair, a table-leg or other object even before their legs are able to bear the weight of the body. An observer says of a little girl ten months old—" this child could climb upon chairs, upon the table and upon the refrigerator before she could walk. She had several falls, but nothing would stop this desire to climb until she learned to walk, then it seemed to pass away." There is a desire in the child to get up higher. This impulse leads it not only to draw the body into a standing position but also to get to the top of every attainable object. In the case cited, the desire to climb was inhibited by the ability to walk. This is not common in children, as the ability to walk simply opens

a wider range for their activity and thus favors it by an increased muscular vigor. Fear of high places or of falling is not at all common in the first acts of climbing. It is only after they have had several calamitous experiences that fear in some case may restrain this activity.

As the child grows in strength, the skill it acquires as a climber is quite remarkable at times, from chairs, tables and other furniture to fences, gates, ladders and trees. It tries an experiment continually to get into some new position and relation with an object with which it is engaged. One little fellow tried, after climbing to the highest part of a chair, to put himself through every open space in it. It was a pure love of climbing that engaged his attention for a half an hour.

M., 3 yrs. Everett is very fond of climbing up in and down out of wagons. He does it just for the sake of climbing. He always gets down backwards and never allows any one to help him.

F., 11 yrs. When I was small I climbed on the table set for tea and tipped it over. I was punished and much frightened, but it did not restrain my desire for climbing. When I went out into the yard, I climbed upon the top of a pig pen and fell in. The pig ate my hat and tore my dress, but I was rescued. The next day I was found on top of the same pen. I was afraid of the pig inside but I wanted to climb.

M., 2 yrs. At the age of 1½ years he was climbing all the time on chairs, high chairs, step ladders, etc. It was easier for him to get up than to get down.

F., 4 yrs. I had a great desire to climb up into the trees in the orchard. Mamma was often frightened to see me so high in a cherry tree. The higher I could get the better I liked it.

M., 14 mos. When John learned to walk he wanted to climb. One day he got on the table and broke his arm. After it had only been dressed one half hour, he got up on the chair near the window and broke the glass.

F., 10 mos. This child, before she could walk, would climb upon chairs and on the table. She climbed upon the refrigerator from a chair. She had several falls but nothing would stop her until she learned to walk, then her love for climbing seemed to pass away.

M., 18 mos. The door was open so that the child got out. When his mother found him he was climbing upon the horse trough.

M., 2 yrs. Wilbur would run away and climb upon every object he could find. Into the most dangerous places.

M., 14 mos. This child climbed into a chair, then upon the sewing machine, then on a desk a little higher.

Children first learn to get off of a bed or a chair and to go up and down stairs after they have learned to creep. It appears as a desire to follow a grown person, or a desire to explore together with the desire to climb. In getting off a bed the greater number of children creep or hitch along to the edge, then turn over on the belly, seize the bed clothes firmly with their hands and slide the body off the edge, holding with their hands, until the feet touch the floor, or drop heavily. Others, though few in numbers, slide off head foremost, by putting the

hands upon the floor and drawing the body after. One case was noted where a little girl rolled to the edge of the bed and then rolled off upon the floor, falling heavily; she repeated the process two or three times, but found it too painful, and after that remained upon the bed until some one took her down.

F. In getting off a bed she would lie on her stomach and keep backing down until her feet reached the floor.

F. She got off a bed by hitching over to the edge and then turning over on her face, she would grasp the clothes with both hands, slide both legs off, and then when nearly down let herself drop.

F., 2 years. If she was on a chair, or a bed, and wanted to get down, she would slide off on her stomach, if she could n't reach the floor, she would let loose and drop down the rest of the way, regardless of bumps.

M., 2 yrs. In getting off a bed he first puts his hands on the floor and slides the rest of his body after. He can walk well.

F., 9 mos. If baby wanted to get out of the bed, she would roll near the edge and then roll out upon the floor; she tried this several times and found that the bump was too great to endure.

In going up and down stairs, of the different ways employed the most common is creeping, in which the child goes up on its hands and knees or hands and feet; in coming down it will creep backwards, putting down its feet first on the next lower step. A child, in both ascending and descending a flight of stairs, will often turn to see how far up it has gone. Another manner of climbing stairs is that of creeping up and then turn and sit down on the step and slide down to the next one below, using the hands to steady the body. Some children go up stairs by drawing themselves up alongside of the banister with their hands and step up with their feet. This is a more mature method and is only employed by those children who have already learned to walk. An exception to the general manner is found in a little boy who went down stairs head foremost. He put his hands on the step and then let the body slide down after him.

F. In going up stairs she would place both hands on a step, then bring up both feet to the next lower step, and so proceed. In going down she would sit on a step and slide down to the next lower.

M., 14 mos. Soon after Harold learned to walk he began to go up and down stairs by holding on to the banister.

The child goes up stairs on its hands and feet and backs down in the same manner.

F., 2 yrs. In coming down stairs, Dorothy would sit down on a step, straighten out her body and slide down to the next one. In going up she would put one foot on the step above and taking hold of the railing would lift herself up until both feet were on the step.

15 mos. It placed the left foot on the lower step and brought down the right knee on the level with it; the child could hardly creep, but in this manner it learned to walk.

13 mos. This child often sits on a step and then slides down to the next lower, using the hands to keep from tipping forward.

M., 21 mos. Everett took hold of the banister and put one foot upon

the step, then drew the body and the other foot up. He rested awhile and repeated the act on the next step.

M., 2 yrs. Thomas always goes down stairs head first; he first puts his hands on the step and slides the body down behind him.

F., 18 mos. In going down stairs she laid flat on her stomach with her right leg and foot bent up acting like a rudder, the left leg extended straight from the body, and the hands rested on the step above as she descended. In this way she slid down the stairs as fast as one could run down. She crawled up on her hands and knees.

Rising into the Standing Position.

The child has learned to sit up by grasping a person's extended fingers and is thus pulled up. It will seize every available object within its reach. After it has learned to creep or hitch, and in some instances while still sitting in the lap, it will seize the extended fingers or other objects and brace its feet so that it may be raised into a standing position. [1]Mrs. W. S. Hall observed a child in the thirty-eighth week; he stretched his body and right hand toward his baby-carriage, within reach, and seized the handle firmly which he drew near enough to grasp with both hands. He then braced his feet against his mother's lap and pulled himself up, swaying back and forth, alternately pushing and pulling the carriage. He also pulled himself up by the extended fingers of the mother and remained standing a minute, when he was laid back upon the floor to rise again, this time standing two minutes. Several weeks later, at twelve months, he was able to rise by the aid of a chair, and remain standing for five minutes, holding to the chair with one hand while playing with the other. Some children delay standing if they are not given the initial suggestion, as was seen in Mrs. Hall's child, but are content to creep, until suddenly they will be seen rising up in the center of a room without support; first, from the creeping position to the hands and feet, they raise one hand carefully and place it upon the knee as a brace, and finally, with considerable unsteadiness, raise the body erect.

M., 12 mos. One day Melbourne was creeping on the floor when he saw something on a chair. He did not creep over to the chair, but stood upon his hands and feet, then raised one hand from the floor and soon raised himself up. He stood a moment as if to balance himself, then took two or three steps. He then took hold of the chair, got the object he wanted and sat down. After this he most always got up from the floor in this manner. This attempt was unconscious, for after he obtained the object he sat down and did not seem to realize that he had done anything unusual. It made his breath come faster.

F., 10 mos. Daisy, when learning to walk, simply rose from the floor, stood up and walked away. This was the first time she had walked at all.

F., 9 mos. Francisca never crept. One day she was sitting on the

[1]Child Study Monthly, Dec., 1896, p. 398.

floor and suddenly got up and started to walk. After walking awhile she fell; she laughed, got up again and started off.

M., 1 yr. Frederick was sitting on the floor. His mother came near him when he seized her dress tightly and pulled himself upon his feet. He stood for a moment and would have fallen had his mother not held him.

Standing. The child first stands resting its partial weight upon its legs when supported in its mother's or nurse's lap. The body is inclined forward, the knees and hips are bent. As the muscles of the back and legs develop the limbs are brought into line with the trunk, the spine assumes its double curvature, the child stands supported only by steadying itself near a chair or near the wall. The age at which children first are able to bear their entire weight unsupported upon their limbs varies from seven to sixteen months, the large number falling between ten and twelve months. Frequently, children who are not encouraged to rest their weight upon their feet do not show an early desire to do so. Mrs. W. S. Hall observed that the child braced himself in a standing position on the 135th day (4½ months). After that he was permitted to bear a part of his weight in standing when he desired. In this position children soon learn to alternate the use of their hands in supporting the body near a chair and may remain upon their feet for a half an hour at a time moving the hands and feet continually. When children arrive at this stage of development, there is a constant desire to remain upon the floor. One observer remarks that there was a great unwillingness to be taken up from the floor for meals, the child tried to take its food while standing.

The child learns to stand in the mother's lap and with her assistance, later, it learns to stand by means of a chair or wall. The first efforts were unconscious.

M., 8 mos. The first time Albert stood alone he was put near his carriage and had nothing to support him but the handles of the carriage. He was unconscious of it.

F. Edna would get a hold of the leg of a chair and pull herself up, sometimes making several attempts before succeeding. At times these efforts appeared entirely unconscious, at other times conscious. Her first steps were taken around a chair, then she went from one chair to another.

F., 16 mos. Nellie came and took hold of my dress and pulled herself up and stood for some time. I took her up, but she objected to this and let herself down and crept away. This was the first time it had been noticed that she stood. It seemed to be unconscious. Two weeks later she stood alone in the middle of the floor laughing and waving her hand. She received a severe bump which made her afraid to rise up unsupported until she had learned to walk.

M. Leon was creeping on the floor, and catching hold of the rounds of a chair he pulled himself up. He stood up because he wanted to, as there was no inducement offered. He was very proud of it. A fall which he received made him timid.

M., 1 yr. Marvin's first steps were beside a sofa. They were unconscious, for as soon as he realized what he was doing he fell.

F., 10 mos. The first effort Barbara made to stand was near her mother's knee. It seemed unconscious. Her breath seemed to be shorter.

F., 8½ mos. Alice's first attempt to stand was when she drew herself up by holding on to the table legs.

Movements Anticipating Walking.

For the first three months of the child's life the movements of the limbs are the so-called instinctive, reflex or organic. The limbs are bent most at the shoulder and hip joints. The large supra-spinatus and the infra-spinatus muscles of the shoulders are functioned at birth, making possible this movement of the arms, which is not in the same plane with a line parallel with the axis of the body, but varying about 20° toward the body from this plane, causing the hands to move mouthward rather than forward. The intentional flexion, as Mrs. W. S. Hall has observed, develops earlier than the corresponding extension. The child could put his thumb into his mouth, at will, but could not remove it. In the leg, the greatest amount of the early movement is caused by the flexion and extension of the psoas, iliacus and pectineus, which lie in front of the joint and the gluteus maximus and medius muscles which draw the leg into line with the trunk. At three months, the child of normal development is, without doubt, conscious of these limb movements which are gradually becoming more rhythmic and co-ordinated. They give him considerable pleasure, which exists in the consciousness of an ability to do, as observers think, rather than in the exercise itself. The arms and legs at times are moving quite in unison. Soon after this period, there appears the response to a stimulus applied to the soles of the feet, the tendency to push. When supported erect, the desire to jump, until the standing position is acquired, after which comes the alternating movement of the legs as above mentioned.

Walking. From the standing position it is a short step to walking. The first step is usually taken alongside of a chair or the wall. The legs have already learned the alternating movements by creeping and jumping in the lap or kicking. Very frequently the first steps are taken by lifting the feet and placing them again in the same tracks. Gradually the body moves and the legs are brought forward or backward to maintain the equilibrium. The chair may accidently move and the child follow it by taking a step. Then follow the movements from one object to another placed a short distance apart, or walking beside a person holding firmly to the hand or dress. One little girl at nine months of age at first clutched a person's dress in walking, then she seized the scallops of her embroidery on the bottom of her own dress and walked off bravely, feeling

perfectly safe. Frequently a child will not use a chair, wall or other object at all, it will rise up in the centre of a room and steady itself, then take several steps unsupported.

Some children walk by pushing a chair about a room, thus continually steadying the body; others are assisted by their parents, who support the weight of the body, allowing the feet to touch the floor and the legs to move. When left to themselves after this exercise, they will attempt the movement alone, and at times will succeed quite as well. At first children are afraid to let go their hold of a support, unless some especially attractive object or considerable encouragement from the attendants makes them forget the bodily state and they totter along unconsciously. After confidence is acquired, they reluctantly return to creeping, and prefer walking even to riding.

Children, as a rule, walk "pigeon toed," and it is only by a process of growth that the feet assume a proper angle and the legs become straight from the "bowed" condition at birth.

M., 11 mos. Albert was playing with the front part of the carriage when suddenly he began to walk, being unconscious of what he was doing.

F. She could stand alone near a chair or wall. The first steps were taken while leaning against the wall. Her mamma stood a few steps off with her outstretched arms coaxing the child to come to her. She ran into her mother's arms and repeatedly did so until she could walk alone.

F. Her first steps alone were in going from a chair to a person's arms a yard distant. She tried it very timidly at first and fell several times in the attempt. At last she succeeded and was so perfectly delighted to think that she could walk without help.

M., 11 mos. Harold walked toward a little dog which he had not seen before. I do not believe he was conscious of what he was doing for he was so intent on the dog. After this he walked so much that he could not rest at night.

M. Leon's first steps were taken between two chairs. After he had learned to walk, he would tire himself out so as to be sick.

M., 10 mos. Jack was creeping one day, when he came to his chair he stopped suddenly and looked up. By the aid of his arms he pulled himself up slowly and carefully on his feet (all during the process his tongue was out), at last one hand reached the seat of the chair and Jack was on his feet. He began to spring and laugh then turned to his mother, who was opposite, and made three steps to her knee, balancing himself by holding out both arms. He was so well pleased that for several days he would always go to the same chair and begin his walk.

F., 9 mos. Alice's first steps were taken when she was 9 months old. She walked by pushing a chair around the room. At times she would leave the chair and take a few steps toward her mother who stood near.

M., 10 mos. Frank could stand by holding fast to chairs, table legs, etc., but he had not walked. One day while he stood near a chair, his mother invited him to come to her. He started and walked all the way across the room to her. He was very proud of this feat, although he did not walk alone again for two weeks, during which time he clung to the chairs and the walls.

F., 11 mos. The first unsupported steps were taken between two persons sitting about four feet apart, they were quite conscious, being the

result of considerable coaxing. The steps were carefully taken, the body settling firmly at each step, the arms were extended. There was a decided leaning forward of the body with the right side a little forward of the left. She has only walked when asked to do so.

Consciousness of Standing and Walking.

Several questions will arise at this point which it will be well to consider. First—are these first efforts to change the verticality of the body in standing and walking, conscious efforts on the part of children? Second—what are the effects of standing and walking upon the physical organism? Third—how do they effect the psychic life?

Let us consider the questions in the order in which they arise. First—are the first efforts to stand and walk conscious? The writer realizes the difficulties into which this question at once plunges one, since it involves the whole question of the relation of consciousness to life.

The returns in answer to this question are not at all unanimous, since they confirm both the consciousness as well as the unconsciousness of the movement. A careful study of them, however, does not reveal such a diversity, as it shows that the observations were made at different stages of the child's development and upon different children. Let us consider several concrete cases. A boy nineteen months old, who had never stood alone, while sitting upon the floor saw a fly on the wall. He took hold of the table leg near him and rose on his knees, he then stood that way for a time, then by degrees he rose to his feet. When he was up he looked for the fly which had gone. He sat down with a thump and did not try to stand again for five months. A little girl, one year old, saw some candy in a chair, she crept to the chair, then climbed up and stood unsupported. As soon as she seemed to think of what she was doing she sat down. Her breath then came fast. Another child saw his mother handling his red dressed doll; he crept to her, pulled himself up and stood. The observer believes that he was entirely unconscious of all else but the red dress of his doll.

Another example is given by Professor Kirkpatrick of Supt. Hall's little girl. She was, in all respects, a normal child, but unable to walk at seventeen month of age. One day the father came home to dinner and placed his cuffs upon a table and laid down to rest. The child, seeing the cuffs, crept to the table, pulled herself up by the leg of the table, took the cuffs, one at a time, and slipped them over her wrists, standing unsupported while doing it. She then stood looking very much interested in the cuffs. Then, to the great surprise of the father, she walked with great confidence with a pleased expression on her face. She also ran, continuing this for ten minutes, then sat

down and rested, after which she arose alone and walked again. Without the cuffs, however, she could not be induced to take a single step. She was given an old pair of cuffs and she seemed greatly delighted; she walked and ran as before. She used the cuffs for two days, after which she walked without them and did not revert to crawling.

There are many other observations which might be cited to show that the evidence is against the popular thought that the child must learn to make these movements. That he must, from the infinite number of possible movements, select, from the four hundred muscles which move, the right muscles and the correct combinations of these to enable him to move. This task would be too enormous for the space of a year or fifteen months.

Another view is that walking is entirely instinctive and that it is inherited as in the young animal; but, as Prof. Bain says, the mechanism at birth is not completed. There are children who walk the very first time they make the attempt, so that this view has much in favor of it. But the walking in a large number of children will not support this theory by the evidence it gives.

We are then given a third view, that often held by psychologists and physiologists. This theory sets forth the play between the unconscious and the conscious elements.

Common observation shows that the reflex movements of early life are a natural concomitant of the organism and become established in consciousness, and consciousness in turn assumes a directive control over these organic movements and builds up complex groups, which in turn make possible more complicated movements. Very early in the infant's life it can be seen attempting to imitate a movement which it has seen, or when it is intensely interested in the movement of a person its body will respond very markedly. This does not seem to be a matter of chance, but there is undoubtedly physiologically a close connection between the visual and the motor centers. This physiological part determines the direction of the impulse.

A child sees an object, he grasps it. The visual sensations call into play the movements of the proper muscles. The conscious element is the visual image, the motor element is unconscious.

I am practicing to throw a ball at a target. The attention is focused upon a spot in the center of the target, that alone is in consciousness, the movements of the arms, the position of the body and legs all adjust themselves unconsciously to meet the impulse from the sensory center. The same is seen in the case of a child's walking. He has a visual impression, a fly, a red dress or what not, this is sufficient to call into action the motor apparatus at the time when it is developed sufficiently.

The close relationship existing between the sensory and the motor centers makes possible even new co-ordinations with the attention directed toward the former and surrendering wholly to the unconscious the motor element.

Let us suppose the child sitting upon the floor; he is able to creep but does not take any steps. He sees a fly upon the wall. A visual impulse comes to him, it is strong enough to absorb his attention, and movement results. The functional development has advanced sufficiently that the co-ordination may be made. The child rises up and stands. Or another child's attention is entirely concentrated upon the getting of the cuffs, putting them on, etc. The attention is not, in either of these cases, upon the movements, for when the visual image is removed, the motor image arises, the newness of the situation at once destroys the co-ordination, and the child sits down. The direction of the attention toward the movement disturbs co-ordinations of movements rather than favors them in children as well as in adults. But there is another element which enters in. Many children, before they are strong enough to walk are held upon the floor or table with their feet touching which no doubt suggests walking, they are urged and guided and led. Here the conscious states no doubt precede the functional, since we can see such children trying to repeat the position and movements which have been suggested to them in this manner by their parents or nurses. This is, however, reversing the biological order of development.

F., 13 mos. Gladys pulled herself up by her mother's dress, after she became conscious of her power she felt very proud of it. Her breath was short from the effort of it.

M. Tommie's mother had a doll dressed in a bright red dress in her hand. Tommie was sitting on the floor near his mother when he became so interested in this doll that he pulled himself up by her dress and tried to reach it. I think he was entirely unconscious of what he was doing, except that he saw the doll. After he had got on his feet he stood for a few seconds.

F., 24 mos. Alice first tried to stand by pulling herself up by chairs, etc. I think the first efforts were unconscious for she usually made them while trying to reach something. After she had made her first successful attempt she looked around to see if anybody had noticed her.

F., 1 yr. Margaret was sitting on the floor beside a chair, she tried to stand by taking hold of the chair, but failed. She made several attempts before she succeeded. Finally after she had stood for a few moments she looked around to see if any one was seeing her and smiled. I think she was conscious of the act.

M., 11 mos. John was placed in a wash-tub with cushions in the bottom. He reached up and placed his hands on the side of the tub and then tried to stand on his feet. At first he was on his knees then stood on one foot. He would fall, but not be discouraged. He worked fully five minutes trying to get on his feet, his face was moving and his breath came quickly. After he succeeded in standing up he began to laugh.

Physical Effects of Standing and Walking.

Second—What are the effects of standing and walking upon the body? In the first place, after children have learned to walk and have gained confidence, they become passionately fond of it and, Gross has observed the same fact with reference to their play, there is a tendency to walk until exhausted, which produces a general physical change. This fact seems sufficient to break down the surplus energy and pleasure and pain theories of walking as well as playing. The metabolic processes are increased, the circulation of the blood becomes more rapid, the respiration increases, the appetite often increases to a marked degree. Children who have been pale and sickly before, often become ruddy and strong, possessed with new life and over-flowing with energy. At the time the first step is taken, the face becomes flushed, the breath short and panting and the whole body often trembles with excitement and eagerness. The fatigue which sets in, is at times so great that sleep is impossible, and when induced the body twitches and tosses from side to side.

Effects on Different Parts of the Organism. The change produced on the muscular system by walking is most marked. The great muscles of the calf of the leg, the tricept extensor suræ, are much increased in size, the psoas ilíacus and pectinéus of the upper part of the leg become hard and resisting. At first, there may be a marked decrease in the size and fullness of the leg which is due to the rapid loss of fat before the muscles have had time to develop. The great glutaei muscles of the buttock and the erector muscles of the spine grow in size and complexity, the latter fill up the vertebral grooves and send up tendons along the back like stays supporting the masts of a ship. These are the characteristic muscles of man and they are comparatively undeveloped previous to this time.

But muscles are easily fatigued and in order to compensate this, the joints and ligaments are fully developed. The body is so held that the center of gravity falls directly upon the ankle-joint, this produces the greatest stability and reduces the muscular force to a minimum. At the knee the center of gravity falls a little in front of the axis of the limb, the back and sides of the joints are provided with check ligaments to hold the joint locked in a position of hyper-extension, so that no muscular force is required to maintain it. In the first efforts of the child to stand, the knee is bent forward hanging the entire weight of the body in the contraction of the muscles, but as he extends the legs the joints become locked and static.

M., 5 yrs. Theodore never liked to be dirty nor romp out of doors, he eats very little, is pale, good tempered and always quiet.

F., 2 yrs. Edith is always running about and would much rather climb and run than play with her dolls. Her circulation is good, her

cheeks have color, she is always full of life. I think it is the romping out-door life that makes her physical condition so different from her brother's.

F. When she had walked until tired, she would continually fall down.

F., 12 mos. Marie seemed to grow more after she commenced to walk.

M. When Walton first stood he got very nervous. In a short time he would fall down. There was a tendency to use his hands more. He became stronger, healthier and more active as he walked more. He required more food. He often ran away.

M. After he found that he could walk he was doing it all the time, when asleep he would moan and twitch from sheer exhaustion.

F., 2 yrs. Alma was very sick until she was two years old. Then she began to walk and she gained in health. She was entirely well at four years of age.

At this time there is a marked increase in the size and fullness of the legs.

F., 2 yrs. The child had walked for some time, one morning she could not use her legs at all. She had n't been sick nor had she fallen. The doctor could not account for it. By constant rubbing for two days she was able to walk again.

M. As soon as the child began to walk, his appetite was better but he became thinner.

The child got so fatigued that it could not rest at night. Children as a rule walk too much.

M., 18 mos. There was a marked increase in the child's appetite. The general disposition is better, it cried less after it had learned to walk.

F., 16 mos. Her breath was short and quick. There was a marked increase in the size of her legs.

F., 2 yrs. She slept better and had a better appetite and was immensely more mischievous.

Rhythmic Movements of the Arms.

Arms. An increased activity is seen in the movements of the arms and hands. There is a rhythmic movement in the arms which alternates with the movements of the legs. The child also has a passion for carrying objects. One child could walk more securely when it carried in its hand the folds of its dress. Several observers noticed that the child acquired greater skill in the use of its hands in examining various objects, while walking. This is due to the general development of the muscular system and it also absorbs the attention of the child, giving the lower center fair play.

M., 10 mos. At this time the arms are used also as much as the legs.

M., 14 mos. After walking he made greater use of his hands. Because more active in examining objects round about him.

Children like to use their hands carrying things while walking.

F., 20 mos. The child learns to use its hands more successfully when it learns to walk.

Mental Effects.

F., 16 mos. When she succeeded in standing she laughed and crowed.

F., 2 yrs. After Magdeline learned to walk she seemed to be a great deal happier.

F., 10 mos. Helen was happy whenever she made a step, she would look around and laugh, then would jump up and down by bending her knees, without raising her feet from the floor.

M., 11 mos. Since Fred learned to walk there has been a marked change in his temper. He was very cross and cried easily, now he rarely cries.

M., 1 yr. The child seemed happier and sweeter tempered after he learned to walk.

Third—How does standing and walking affect the child mentally? With the ability to creep there comes a desire in the child to push out and enlarge its sphere of activity. This desire is increased with the ability to walk. There is a keen desire to explore every unknown region and to examine every unfamiliar object. The emotional life receives a new stimulus. The child becomes elated over its own accomplishments. How the little one laughs for joy when it can rise up near a chair and is conscious that some one is seeing it. One observer writes that the "little girl slapped the seat of the chair near which she was standing with her hands, then turned to her mother with an expression of great pleasure upon her face."

The child grows happier in spirit, it can busy itself in its walks by examining new objects, thus receiving new external stimuli. One mother says—"After Fred learned to walk there has been a marked change in his temper. He was very cross and irritable, he cried very easily, now he rarely cries."

Should Parents Assist Children in Learning to Walk?

The question was asked whether parents should assist children in learning to walk. There were seventy-five answers given, all of which indicate very clearly the one fact. That is, that the assistance of parents should be to prevent falling, which incurs physical injury, discouragement or fear. But they should not lend this assistance until the child first makes the advances, nor should they encourage the child at any stage except as it may lack courage, or if there is danger of post maturity. This is fundamentally in accord with the line of development. At the functional stage the desire appears in the normal child; but it may be inhibited by the effect of another stimulus as was seen in the child who stopped climbing after he had learned to creep. The physiological effect of walking is important here. After an organism has functioned, the growth is much more rapid, we see this in the case of a boy who was very small and pale and inactive until he learned to creep and walk, then the whole organism apparently received new life, the metabolic processes increased and the child grew strong.

Post maturity may thus be avoided by the suggestions and assistance of parents without endangering the normal development of the lower limbs.

These returns leave no place for the walking chair nor any other mechanical devices of body braces, etc., for the child's assistance, and they agree with Dr. Ploss that the child will learn by its own efforts. But there is a deep pedagogical principle underlying the co-ordinations of these early attempts. If the average normal individual can be assisted at the proper times so as to avoid the dangers of mental discouragement, the realization of his growing power will soon be evident. Few children have sufficient combativeness to prevent, at this time, a breaking down of the co-ordinations which have formed in the nerve centers during the earlier successful attempts by injurious falls. The problem of the psychology of success is awaiting a scientific investigation, but it is a matter of common experience that every successful step is so much gain in favor of the next succeeding. Let the individual feel that he *can* do, and having once experienced the doing he is essentially stronger physically as well as mentally for the next similar action. Observations made upon children show that they are indeed very responsive to such conditions.

Reversion.

According to the famous riddle of the sphinx, man shall again surrender his upright posture and turn his face toward the earth from whence he came.

We have thus far traced his rise, let us now observe some of the causes of his reversion. For a considerable time after children have learned to walk and run, they frequently revert to their early stage of creeping, due to some physical or psychic disturbance. The effect upon the organism, of whatever cause, may be temporary or permanent.

The temporary reversions may be due to—fits of anger and crying or laughter mingled with fatigue; to fear resulting from a fall; to various children's diseases which divest the organism of strength during the early walking stage, so that the child, upon recovery, must learn to walk "over again." When the child is asleep the body curls up, approaching its earlier stages, or when in a hurry the early creeping movements will be resumed. While insanity, deformities, nervous and muscular diseases more frequently cause permanent reversions and old age completes the cycle.

Let us now consider more in detail these tendencies so common, yet so unfamiliar, in the development of the human being.

A fall during the early walking stage, which does not produce physical injury or cause fear, is of little consequence to the

average child. It simply has the effect of a slight annoyance which only invites greater persistence. But if the fall produces a physical injury or is of a serious nature to frighten the child, it becomes exceeding discouraged, which will frequently destroy all confidence even to make an attempt for days, weeks, and in extreme cases even years. One observer speaks of a child who, while attempting to walk, fell upon a lifter which was lying upon the floor and cut his head. He became so discouraged that he did not attempt to walk again for almost two months. Another mentions a little girl two years old who had walked for about two weeks when she received a severe fall. It made her so timid that she would not attempt to stand up after that for a month. When urged to walk by her mother she would say—"I's 'fraid."

Miss Shinn has observed an interesting point in her niece. While the child was on a railroad trip, with its parents, of five days' duration, during the early walking stage, and was carried much in the arms, she became less disposed to stand and creep. For when she returned, she crept shorter distances, she only reached toward some desired place or object; and when the distance was about 12 or 15 feet she would creep it unobserved, but if noticed, she wished to be carried.

Effect of Falling.

F., 10 mos. She seemed to enjoy falling as she never hurt herself by it. She always tried again after a fall.

F., 2 yrs. When Sarah was two years old she fell down stairs while trying to walk down. From that time until she was four years old, she would never try again, but must be carried down.

F., 1 yr. Helen, while learning to walk had a severe fall, and was hurt quite badly. For about a week she would not even try to stand and seemed very timid when she finally did try.

M., 6 yrs. This child could walk very well when two years old. He received a bad fall which injured his spine, after that, it was a year before he walked again. He is now six years old, and yet, when he walks, he drags his feet.

M. When attempting to walk he fell upon a lifter which was lying upon the floor and cut his head. He was so discouraged that he did not attempt to walk for almost two months.

F., 2 yrs. Ruth had walked for about two weeks when she received a severe fall, which made her so timid that she would not attempt to stand up after that for a month. When asked to walk she said—"I's afraid."

F., 16 mos. When she fell, she was not at all dismayed or discouraged.

F., 10 mos. When Marie fell she would not try to walk again for some time, it frightened her.

M. The falls which this child had were not of a serious nature and after each he would get up and try again.

Effect of Fright.

M. A little boy who had not been seen to stand alone before was noticed one day to stand in the middle of the floor. Several persons

who saw him cried aloud in surprise. The child sat down and could not be made to stand again for some months, the cries having frightened him.

F., 10 mos. One day Helen laughed and jumped so much that she got out of breath and fell over, she showed by the expression on her face that she thought that I had thrown her over and was afraid of me for some time, yet she tried again.

M., 21 mos. When warm weather came, Russell ran out of doors and climbed up the grape arbor. When he got up a certain height where he could go no farther, he began to be frightened. He was aided in getting down by the observer and after that avoided the arbor.

F. Elizabeth gained better control of her hands when she walked, she would go to her mother's work basket and carry away the thimble and thread. One day she pricked her finger with a needle and after that she was afraid to go near the basket.

HURRY.

F., 20 mos. When twenty months old she would run away, but whenever she wanted to get anywhere in a hurry she would always get down on the floor and creep faster than she could walk.

This child had the habit of creeping on its elbows and knees, but when it wanted to go faster it would roll over and over.

F., 12 mos. When Retta had learned to stand and take several steps alongside a chair and saw an object that she wanted to get quickly she would roll over and over toward it, this being her earlier manner of locomotion. This was also the method employed by her mother in childhood.

M., 9 mos. His natural manner of movement was on his stomach pushing himself forward with his hands and knees. When in a hurry, he spread his hands and feet so that he seemed to crawl like a crab.

M., 8½ mos. G. creeps in several ways. If he sees something which he wants, he first gets on his hands and knees and starts forward. This way does not seem fast enough, so he turns and pushes himself backward (still on his hands and knees). Finally, as if all impatient, he lies down flat upon his back and rolls over and over until he reaches the object. He always tries these three methods if he is in a hurry, but ordinarily he simply creeps, usually backwards.

Laughing. The physical act of laughing, as described in [1]Drs. Hall and Allen's study on the "Psychology of Tickling, Laughing, and the Comic," appears to be one of the very common causes of reversion. At first laughing causes a "feeling of bubbling over," "a ticklish sensation in the stomach," a feeling to "laugh or burst," as a "store of energy which must be expended to relieve a strain," and various other feelings akin to these. Then the lips curl, the body becomes unsteady and sways back and forth, the head is at first thrown back and the mouth opened wide, then the muscles of the neck jerk, the head falls forward, the shoulders shake, and the body doubles up convulsively. Sometimes the subject may fall upon the floor and end with sobs and crying or is seated doubled up with his elbows akimbo or planted upon the knees holding his sides; the body rocking violently back and forth. The limbs jerk, the

[1] *Am. Jour. of Psy.*, Vol VIII, No. 2.

feet stamp and the fists pound. The breast heaves and the diaphragm moves at times almost convulsively. Little children jump up and down, lie on the floor and roll all over the room. The fit of laughter is followed by a state of fatigue and soberness with intermittent sighs, heavy breathing, weakness localized in various parts of the body, stitch in the side and soreness, sweating, chills, uncontrollable movements, etc. A study of the physiological effects of violent laughter, as has been shown by Dr. Hall in the majority of adults, are first seen to begin with the highest level in consciousness, of the Hughlings-Jackson theory, "with the finer muscles, and passes downward to lower levels and more fundamental and early developed musculature, although in some children this order is exactly reversed. Expectation, perhaps all that is available, is strongly generated in the higher regions of consciousness; the resulting movements pass down the genetic and perhaps meristic levels till circulation, glandular, and even intestinal and excretory activities are affected and the sphinters relaxed. Let us now consider a little further the physiological effects of laughing and crying as well, since their effects are the same physiologically whatever other differences there may be. [1] The weight of the viscera in quadrupeds is hung from the horizontal spine by means of a strong elastic suspensory bandage of fascia, the tunica abdominalis. In man, who has assumed the erect position, the weight of the visceral organs is thrown upon the long girdle, hence the pelvis has adapted itself by becoming more dish-like. The tunica abdominalis, in man, near the thorax has entirely disappeared; in the groin, where it is of use, it still remains to strengthen the weak parts. It is quite common in children that a fit of crying or violent laughter may cause such intense downward pressure that the muscular ligament of the abdomen is insufficient to withstand it and the ligament breaks, which is testified by the prevalence of hernia. A mild form of the strain upon these comparatively unsupported parts is evident in the feeling of weakness, the stitch in the side and soreness in the groins. As the body is thrown forward in violent laughter, and doubled up, these parts are considerably strengthened by a counter pressure of the legs and ribs as they approach each other.

Sleep. All the various positions assumed during sleep are reversionary, except the one in which the subject lies upon his back. [2] Dr. Osborne has investigated the most favorable position at the various ages of life. He found that children under fourteen years sleep equally on the right side, the left side and on the

[1] D. F. Baker: Am. Assoc. for Adv. Viscera, 1890.
[2] Osborne: Dublin Quarterly Journal of Med. Science, 1859, Vol. XXVIII.

back; but that young girls and youths from fourteen to twenty years of age sleep most often on the right side. Fifty-nine cases slept on right side, twenty-nine on the back and twenty-three on the left side. In the side positions the arms and legs are curled up near the body and the spinal column more or less curved forward. Soldiers have also been observed to sleep more often on the right side than on the left. [1]Marie de Manacéine has for the last five or six years made observations concerning the favorable effects of changing the positions of the body as often as possible during sleep and believes it to be hygienic for a person to lie upon the stomach at least half an hour every morning before rising. She has observed that this position, if taken every day, exercises a salutary influence on angina pectoris, and other diseases of the chest and throat. Marie de Manacéine has also observed that little children have a marked tendency to sleep in this position, flat on the belly, but they are broken of it, she says, by parents and nurses, evidently from the fear that they may acquire bad habits.

It is evident that man is forced to pay a toll to the god of nature for this privilege, which he has over other creatures, that of turning his face heavenward, by having visited upon him various disorders and diseases from which animals are entirely free.

The influence of the upright position is seen on the circulation. In the horizontal position, the great vein trunks favors an easy flow of blood to the heart without too great acceleration. Dr. Baker[2] has observed two mechanical defects which man, in the vertical position suffers; first, the difficulty of raising the blood through the ascending vena cava, causing congestion of the liver, cardiac dropsy, and other similar disorders, and second, the too rapid delivery through the descending cava, causing syncope or fainting if for any cause the action of the heart is lessened.

Clevenger discovered that the valves of the veins are arranged to favor the horizontal position. In the large vertical trunks, where they would be most effective to resist the action of gravity, Clevenger found in the most important trunks the valves wanting, which causes disorder due to hydrostatic pressure, varicose veins, varicoceli, hemorrhoids, etc. He found them present in some of the horizontal trunks, where, so far as can be determined, they serve no purpose. Place man in bed and the valves are arranged with reference to the action of gravity in the horizontal position.

When the sick man retires or the weary man lies down it is

[1]Marie de Manacéine: Sleep, its Psychology, Pathology, Hygiene and Psychology.

[2]Dr. F. Baker: Am. Assoc. for Adv. of Sc., 1890.

not merely a conventional matter but one of deep physiological significance. Since it adjusts the position of the body to the most favorable condition for the action of the vital organs, as well as a general relaxation of the organs.

There is, also, a word to be said in favor of the position upon the stomach and face from a physiological point of view. It may appear an uncomfortable position, yet children prefer it to any other.

The back position will cause the viscera to rest their weight upon the descending circulatory trunks, at times a stomach full of food is added to the weight and the trunk circulation may be below normal while there may be an abnormal flow of blood to the brain through the ascending aorta. The position in sleep, then, is not a matter of entire indifference, but may have considerable influence upon the general health.

Diseases. The effects of the common children's diseases are of a little more serious nature than those of falling. The organism is depleted of its strength while valuable time is lost at a critical stage in practice. The returns show conclusively that a child may have sufficient strength to carry the body but he has simply forgotten the movements. A pitiful case was reported by a mother whose child had been ill for two weeks with the measles immediately after he had learned to walk. The disease had not been serious, but it had kept him in bed. After recovering, when he tried to walk again, he did not know how to do it. He manifested great surprise and chagrin at his failure, for he remembered that he had walked before. After his mother showed him how to place his feet, he eagerly and successfully followed her instruction. This lighter form of disease depletes the physical strength but temporarily, and upon recovery it is soon restored without entirely destroying the mental image or the nervous co-ordinations. There is, however, another form of disease which strikes at the fundamental root of motor-life, hence it invariably proves fatal to the muscles involved. These are the diseases characterized by the progressive weakness and atrophy of certain groups of muscles, or cerebral lesion which seldom causes paralysis of the lower without similarly affecting the upper extremities.

The term "progressive muscular atrophy" was formerly applied to a single type of disease which was considered a designation for an entire group of diseases. Later study, however, established two distinct diseases instead of one — the first was the "progressive muscular atrophy," as described by Aran and Duchenne; the second pseudo-hypertrophic muscular paralysis. Various different forms of these have been described by recent students. The various types of progressive muscular disease

have been established in accordance with their topographical distribution of atrophy and hypertrophy.

The so-called "progressive muscular atrophy" is a spinal-cord affection which, as a rule, begins late in life. It begins, in general, with an atrophy and a corresponding weakness in the small muscles of the hand, whence it extends from muscle to muscle to the deep muscles of the thenar, to the flexors and extensors of the forearm. Then to the flexors of the upper arm, and finally to the muscles of the trunk, shoulders and back. Duchenne recognized the fact that atrophy may, in exceptional cases, begin in the trunk, shoulders and legs. Sachs[1] observed several cases in which atrophy in the lower extremities began almost simultaneously with that in the upper extremities. As this disease progresses the wasting of the muscles becomes more and more extreme. The patient loses power of locomotion and becomes bed-ridden from which death releases him after many years of annoyance.

Hoffmann cites the case of a girl four years of age: At birth the child was entirely normal, she was able to stand at nine months of age. There was an early abnormal development of adipose tissue. Gradually the child became so weak that she could not stand, could not sit upright in bed, could not turn around without assistance. For a long time she was unable to move her feet and arms. She lost her superfluous amount of fat as the motor disturbances increased gradually and became emaciated especially in the extremities and the trunk.

The face remained full, mentality good, speech normal, mastication unimpaired, the child could turn the head but could not raise it from the pillow. The paralysis was in proportion to the atrophy of the muscles. The nerve-trunks were neither thickened nor sensitive on pressure. The paresis and atrophy of both upper extremities were entirely symmetrical, and the sensation was normal.

The muscles of the back and abdomen were paretic, the long erectors of the back diminished in volume and power. The gluteal and muscles of the thigh were almost completely paralyzed and very atrophic. The muscles of the leg were atrophic and paretic. The movements of the toes were almost normal. The paralysis was symmetrical and flaccid leaving no sensory disturbance.

Muscular Pseudo-Hypertrophy is characterized by its occurrence in early youth. It has been considered as the most pronounced form of primary myopathics, and not of spinal origin. But as new types of muscular diseases were described the cases reported inclined rather to the spinal than to the pseudo-hyper-

[1] Sachs: Nervous Diseases of Children, Chap. XXIII.

trophic form. Recently sufficient evidence has been brought to show that all the primary myopathies are closely related to one another, and that the early described types are but peculiarities in the topographical distribution of diseases which should be included under the broad term of progressive dystrophies. There are various types of the disease which are distributed among the affected parts differently which we cannot mention here. One example will suffice to show the effect upon the muscles of locomotion. The disease is more common in boys than in girls, but inherited through the mother. Its first symptoms are, a weakness in the muscles of the legs, an increase in the size of the calf muscles. The gait becomes wabbling, and the child soon finds difficulty in walking up and down stairs, in climbing upon chairs and off, in raising the body in an erect position, the patient usually "climbs up upon himself." In later stages the patient, if placed upon the floor, lies absolutely prostrate and is unable even to raise the head. Sitting becomes impossible. The patient may lose all power of the lower and upper extremities except the small muscles of the hands consequently the hand may climb up in order to carry up the arm.

Effect of Disease.

M. Herbert had the whooping cough and became so weak that he could not walk. When he got better he had to learn to walk over again.

F., 9 mos. When Alice was learning how to walk she was taken with the measles. After recovering she was very weak and did not attempt to walk for some time. When she did begin, it was like beginning over again. She first began to stand then, finally walk.

This child was taken ill with scarlet fever and did not attempt to walk for six months.

F., 9 mos. When Florence was nine months old she could walk all around the room by pushing a chair. She was taken sick with bowel disorder, after which she did not walk until she was fourteen months old, when she had to learn all over again.

M., 3 yrs. Was taken sick when three years of age, and could not walk after that until six years old.

M., 2½ yrs. My brother walked when nine months old. When he was two and one-half years old he was very ill with spotted fever. After the illness he could not walk but learned again to creep and then walk.

M., 20 mos. When Willie was a year old he could walk quite well. He was taken sick with bowel trouble which left a fever and chills with him all summer. When he got rid of these he could not walk, but had to learn over again.

Idiots and Imbeciles.

In general idiots or imbecile children are awkward in their general movements and considerably retarded in their voluntary co-ordinations.

Dr. Ireland[1] investigated the development of 111 cases of idiots who learned to walk. The average time at which they learned was at the age of 2½ years. Five of these are stated to have begun to walk at one year. This lateness in learning to walk, according to Dr. Ireland's report, may be due, in some cases, to weakness, in others to nervous disease, but there are cases where the child appeared strong and healthy, and the deficiency was in the power of mental guidance. The gait was awkward and was acquired along the line of least expenditure of effort, and it was never changed or improved. If the children were required to walk upon a plank, they were successful according to the degree of intelligent. The most intelligent succeeded best. They balanced the body poorly, the hands were flapped or vibrated about instead of being employed to seize and hold with intelligence.

A comparative study of idiots and imbeciles and normal children produces a valuable suggestion which shows in a measure conclusively the part played by intelligence in learning to walk. The average age at which normal children begin to walk is 12 months. (Dr. J. Crozier Griffith—Care of the Baby.) The imbeciles, according to Dr. Ireland, begin at about 2½ years. There is a difference of 1½ years that the normal child has the advantage. The physically abnormal idiots are ruled out, so that under normal conditions the organisms would function at about the same time in the two cases. But we see a difference of 1½ years. This difference may be due to two causes. First—the psychic activity of the idiot is more sluggish than that of the normal child. He may receive the same stimulations but these do not establish the same associations in consciousness, hence he lacks the prevision of the normal child. This produces the second or physiological cause. The functioning of the organs is delayed because of a failure to take advantage of wholesome exercising and experience. The former to stimulate the organism, the latter to form the basis of new and higher activity. When both the imbecile and the normal child arrive at the age of twelve months, the latter has been responsive and has been stimulated to activity, his bodily organs are stronger; he has profited, the latter has not. One child devises methods to give expression to the natural desire within him, and often changes these; the other accepts the more simple means which require the least mental effort and they are adhered to without change.

[1] Mental Affection of Children.

Conclusions.

[1] "Nature has succeeded in making a man; she can go no farther. Organic evolution has done its work." In the foregoing chapters we have seen how the human organism has assumed the upright position, expressing the fullest range of possibility and the limit of organic evolution. In concluding, let us further consider the effects of this attitude upon the mental life. [2] Masso has said that the mobility of an animal is an index to the intelligence of it. "Among all birds the parrot is the most intelligent, because it makes more use than do all the other birds of its legs, beak and tongue. The elephant is more intelligent than all other wild animals, because he makes use not only of his legs, but also of his snout as organs of movement."

If the state of intelligence depends upon mobility in animals in general, whose limbs are used entirely for locomotion, what an enormous advantage is given to man over other creatures. His bodily size and weight is midway between the small and feeble creatures and the large and clumsy, thus combining grace with strength; and his body is balanced upon one pair of limbs, setting the others free. The movement of the arms is as varied as a free-moving radius of a sphere; add to this the infinite number of movements of the digits and there is a complexity of enormous significance which sends its impulses to the central nervous system. Indeed some of the modern writers consider that human intelligence, as such, has arisen in direct consequence of man's assuming the upright position, [3] so close is the relation existing between the mental life and muscular movements. Many persons consciously experience this in not being able to think if they suppress the muscular movement.

If we accept with Höffding the conclusion that mental and physical activity are not different things, but opposite sides of the same thing, we can accept the axiom that the mind can only be educated through the senses, and the more senses and the better they are developed the greater will be the possibility of the mental power.

Not only are the arms and hands by the erect position to present new and varied stimuli but the eye is raised enlarging the field of vision in the farthest horizon, enabling it to act like a sentinel for the other senses against friend and foe. The eye is placed in the skull so that there may be the greatest possible centration of attention. Perhaps it is that advantage which the senses gain in their wider range that gives man a passion

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[1] Drummond—Ascent of Man, p. 99.
[2] Decennial Volume Clark Univ. Address.
[3] Districker: Bewegungs vorstellungen.

for climbing high hills and mountains, that he may look about over the wide expanse. What a feeling of exultation does he experience as he views the plains, cities and living creatures lying at his feet.

The proud and haughty spirit is not common in short and stooping persons, but it manifests itself iu the strut of the pompous person which plainly over emphasizes the upright position.

The attitude of prayer is not without its significance.

The meek and humble veil their faces and lie prostrate ; the Greek, who stood erect with up lifted countenance offering soul and body to Apollo, the god of health and beauty, furnish us not only a most perfect type of physical strength and beauty but his intellectual power has been the admiration of the world.

Physical and mental life, in the race, in the individual, come into being ; pass through simple to complex stages by a slow process of development ; reach their zenith of power and return, making the cycle complete. But a slight disturbance in either body or mind, a disease, a passion has a tendency to undo shortly what has been a long and difficult process of growth.

It is a pleasure to make acknowledgments to President G. Stanley Hall for suggesting the subject of this paper and for delivering to me a syllabus and a number of returns, also for his valuable suggestions and criticisms from time to time; to the other members of the faculty of Clark University and to the physicians of the city hospitals of Worcester for their assistance from many sources; to Mrs. A. W. Trettien for her assistance in summarizing the results obtained, and to the many others who so carefully recorded and sent the facts of their observations, I am grateful.

DISCRIMINATION OF CLANGS FOR DIFFERENT INTERVALS OF TIME.

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PART II.

I. EXPERIMENTS WITH DISTRACTION.

[NOTE. The writer feels that some explanation is necessary for the length of the "time interval" between the first and second parts of this investigation; it was due to the leaving of some of the data in California—only a part of which the writer has been able to obtain. There are several errors in the tables in the first article [*Amer. Jour. Psy.*, Vol. XI, No. 1]. P. 75, "total = 160" should read "total = 323," and in the line below "1440" should be 1603. On page 77 "total judgments for G" should be "2111" instead of 1211. This article is based on experimentation carried out by Mr. Henry Harwood, A. M.—the collaborator of the writer in Part I of this investigation, where can be found the general tables embodying the results of the experiment. Würzburg, July 8th.]

The experiments with distraction were undertaken partly with a view of testing the memory-image theory of comparison, and partly in the hope that by varying the form of distraction some insight might be obtained into the manner in which two sensations are bound up into a judgment. It was thought that, if the delivery of such a judgment depended on the carrying over of a memory image from the first impression to the second for the purpose of comparison, almost any strong form of distraction should decrease the percentage of right judgments, and that some forms should act with more disturbance than others either because they were more absorbing—that is, inhibited all memory images alike, or because the particular form in which they functioned interfered more strongly with the motor or sensory vehicle of the memory image.

Accordingly for the first group of reagents,—L., W., A., and S. (experiments of '95-'96), five kinds of distraction were used, viz.:

1° Continuous addition of written figures. (Ad.)
2° Counting metronome beats—3 per second. (M1.)
3° Counting metronome beats—1½ per second. (M2.)
4. Reading letters of printed words backwards. (Rdg.)
5. Reading interesting literature aloud (intoning). (Lit.)

As the counting of metronome beats seemed to become mechanical with practice, two other forms of distraction were

substituted with reagents G. and B. (experiments of '96-'97); they were:—

6° Listening to interesting reading. (H'r'g.)

7° Discriminating between pairs of clangs differing by 8, 4 or 0 vibrations. (D'c'n.)

As a comparison of two tones requires a period of at least 3 seconds, and again as it takes an appreciable time for interest to be aroused in listening to reading, these last 2 forms of distraction could not be used for the shorter intervals; they were accordingly applied only to intervals of 10, 20, 30, 40 and 60 seconds. On the other hand it is to be said that distraction for the one second interval can mean only that the 'set' of the reagent's mind is different from that for an unfilled interval.

Inasmuch as the several forms of distraction are applied to six different norms for the reagents G. and B., and to three different norms for reagents L., W.. A., and S., it will first be necessary to consider the relation of pitch to the number of

TABLE V (a).

Percentages of right cases [r] of reagents L., W., A., S., for the norms 540, 560, 580, with differences [△] of 8, 4, 0 vibrations, with and without the Distractions Ad., Rd., Lt., M^1, M^2. Each percentage given is usually based on 72 judgments for norms 560 and 580, and on 36 judgments for norm 540. Nine (9) time intervals from 1 to 60 sec.*

Reagent.	Norm.	No. D'n.		D'n.		No. D'n.		D'n.		No. D'n.		D'n.	
		△	r		r	△	r		r	△	r		r
L.	560	8	94	Ad	96	4	81	Ad	83	0	42	Ad	25
	540	8	98	Rd	94	4	91	Rd	86	0	64	Rd	41
	580	8	91	Lt	87	4	85	Lt	91	0	41	Lt	8
	580	8	96	M^1	93	4	82	M^1	84	0	50	M^1	28
	560	8	92	M^2	98	4	78	M^2	88	0	53	M^2	11
W.	560	8	86	Ad	79	4	60	Ad	64	0	64	Ad	63
	540	8	96	Rd	94	4	84	Rd	72	0	72	Rd	61
	580	8	90	Lt	83	4	78	Lt	75	0	81	Lt	49
	580	8	91	M^1	91	4	74	M^1	66	0	69	M^1	37
	560	8	93	M^2	78	4	66	M^2	68	0	56	M^2	56
A.	560	8	89	Ad	83	4	71	Ad	71	0	72	Ad	60
	540	8	88	Rd	90	4	88	Rd	75	0	73	Rd	63
	580	8	86	Lt	88	4	72	Lt	71	0	78	Lt	65
	580	8	92	M^1	94	4	70	M^1	73	0	83	M^1	56
	560	8	96	M^2	95	4	81	M^2	72	0	70	M^2	42
S.	560	8	59	Ad	42	4	54	Ad	53	0	19	Ad	13
	540	8	64	Rd	73	4	60	Rd	61	0	25	Rd	25
	580	8	60	Lt	61	4	45	Lt	72	0	44	Lt	13
	580	8	57	M^1	66	4	55	M^1	53	0	33	M^1	22
	560	8	49	M^2	47	4	50	M^2	44	0	28	M^2	14

*In the case of A. the percentages are based on 60 to 72 judgments.

TABLE V (b)

Percentage of right cases (r) of reagents G. and B. for norms 540, 560, 576, 640, 660, 768, with differences (△) of 8 4, 0 vibrations with and without Distractions Ad., Rd., Lt., H'r'g, D'c'n. Nine time intervals, 1 to 60 seconds, unless otherwise specified.

Reagent.	Norm.	△	No. D'n.		D'n.		△	No. D'n.		D'n.		△	No. D'n.		D'n.		Kind of D'n.
			No. Cases.	% r	No. Cases.	% r		No. Cases.	% r	No. Cases.	% r		No. Cases.	% r	No. Cases.	% r	
G.	540	8	72	92	72	93	4	67	75	68	88	0	36	67	36	67	Ad.
	560	8	71	93	72	90	4	72	75	72	81	0	36	48	36	31	Rd.
	576	8	72	90	72	76	4	72	76	72	63	0	36	50	36	19	Lt.
	640	8	72	81	70	75	4	71	68	70	55	0	36	47	35	43	H'rg. *
	640	8	64	91	64	73	4	64	66	64	64	0	32	22	32	22	D'c'n.*
	660	8					4	80	79	80	59	0	20	40	20	35	D'c'n.*
	768	8					4	80	64	80	67	0	20	35	20	25	D'c'n.*
B.	540	8	68	93	66	87	4	67	85	68	79	0	36	78	35	66	Ad.
	560	8	72	83	68	84	4	72	93	72	84	0	36	81	36	66	Rd.
	576	8	72	83	70	83	4	72	79	72	67	0	36	75	32	56	Lt.
	640	8	72	76	70	80	4	70	59	67	58	0	35	43	29	34	H'r'g.*
	640	8	64	92	62	77	4	64	73	64	62	0	32	41	32	53	D'c'n.*
	660	8					4	80	77	80	77	0	19	42	20	40	D'c'n.*
	768	8					4	80	42	80	44	0	19	32	20	35	D'c'n.*

*Intervals of 10, 20, 30 40, 60 sec.

right and wrong judgments before proceeding with the discussion of the effects of distraction. Table V gives a summary for all time intervals of the percentage of right judgments for all norms, and for all forms of distraction with the three differences of vibration (8, 4, 0,) between norm and variable. Luft, as is well known, found that the absolute discriminative sensibility was about constant for the region which includes our norms.[1] Wolfe's results on the other hand indicate rather a decrease in the number of right judgments with the increase in height of tone,[2] whilst Meyer reports a fairly constant value for the region 200 to 600 vibrations and a lower value for 100 and 1,200 vibrations[3] with Stumpf as reagent.

Our results with the first set of reagents (Table V a) show more correct judgments for N = 540 than for N = 560 or 580, but in some cases less correct judgments for 560 than for 580. These norms, however, differ so little that for the first set of results the question of the relation of pitch to discriminative sensibility need not be taken into account.

For reagents G. and B., taking the extremes of norms used under similar conditions, the averages for differences of 8 and 4 vibrations (without D) are:—

Per cent. right cases for G. and B.

Norm.	$\Delta = \pm 8$	$\Delta = \pm 4$	Norm.	$\Delta = \pm 4$
540	92.5	80.0	640	66.5
576	86.5	77.5	768	53.0

The experiments with norms 640 and 768 are based on results with time intervals 10 to 60 seconds, and therefore are not strictly to be compared with the results from norms 540 and 576. The indications from these figures are in favor of a decrease in the absolute sensitiveness to difference with increase in pitch; but the mean variation of these averages, if they may bear the name, is too great to permit much reliance to be placed on the indications. We shall, therefore, proceed to the discussion of the distraction experiments without regard to any general law of variation of the liminal difference with pitch.

Of the seven (7) forms of distraction mentioned above, the 'intonation' of interesting literature, and the listening to reading were the most distracting in the sense of being the most

[1] Luft: Ueb. d. Unterschiedsempfindlichheit f. Tonhöhen. Phil. Stud., V, S. 529.
[2] Wolfe: Unt'g ü. d. Tongedächtniss. Phil. Stud., III, S. 561.
[3] Meyer: Ueb. d. Unt'dsemp'k't f. Tonhöhen. *Z. f. Psy.*, XVI, S. 357.

absorbing. Coming after the monotony of the longer intervals in which the attempt was made to hold the mind steadily on the norm, these occupations were accompanied by fairly strong feelings of relief and interest, so that it was found necessary to give a premonitory signal in order that the reagents might pull themselves together for the apprehension of the variable sound. This 'apperceptive signal' was used for intervals above 3 seconds both for experiments with and without distraction. It is hardly necessary to state that the intonation was for the purpose of testing the theory that an inaudible 'Mitsingen' was the vehicle for carrying over the image of the norm to the moment of comparison. This theory, as is remarked by the writers of the first part of this investigation, is highly improbable in view of the relatively small differences used. For the shorter intervals, there was but little chance to become interested in the matter read; but the attempt to comprehend the meaning of a sentence or part of a sentence in the short time interval was hardly less absorbing than 'plot-interest.'

For the reagents of the first group the reading backwards of printed letters and the continuous adding came next in absorbing interest: in the former process particularly, a danger-signal for flagging attention is given from the occasional attempt to read the letters in direct order or even to pronounce the words which the letters compose.

In each of the above 4 occupations the distraction was more continuous and absorbing than was the case with counting metronome beats, where the intervals between successive beats or a mechanical way of counting gave chances for a recall of the norm—the temptation to which was the more insistent because it was to be suppressed.

The distraction by means of comparisons of pairs of clangs was of course undertaken in the hope of applying a 'crux' to the memory-image theory as well as of getting some sort of an estimate of the amount of distraction. It was presumed that during the process of apprehending the sounds and perhaps in the moment of judgment the attention would be wholly occupied: if this were not the case, if the mind of the reagent was more or less occupied with the central sensation of the original norm, it was supposed that the effect would be seen in a diminished number of right distraction cases.

Considering now the total effect of all forms of distraction on each of the reagents, we get the results set down in Table VI.

The most obvious conclusion to be drawn from the following table is that distraction often failed to distract in the sense of diminishing the number of correct judgments: in fact, if distraction had any effect at all on accuracy of judgment for differences of 8 and 4 vibrations between norm and variable, we

TABLE VI.

Number of instances of increase, equality and decrease in percentages of right cases for all forms of distraction as compared with the percentages for undistracted intervals.

	No. of instances of increase in % of right cases with distraction.			No. of instances of equality in % of right cases with distraction.			No. of instances of decrease in % of right cases with distraction.		
$\Delta =$	± 8	± 4	0	± 8	± 4	0	± 8	± 4	0
Reagent L	2	4	0	0	0	0	3	1	5
" W	0	2	0	1	0	1	4	3	4
" A	3	1	0	0	1	0	2	3	5
" S	3	3	0	0	0	1	2	2	4
" G	1	2	0	0	0	1	4	3	4
" B	2	0	1	1	0	0	2	5	4
Total	11	12	1	2	1	3	17	17	26

could conclude that it increased the accuracy about ⅔ as often as it decreased it, and in a few instances had no effect.

Very different are the results or the accompaniments of distraction for $\Delta = 0$: only once do we find any instance where the distraction was accompanied by an increase in accuracy of judgment, while in 26 instances the accuracy was decreased. Here, as in the effects of the flight of time without distraction, the objectively like cases seem to differ indeed from the unlike this stimuli in their relation to the processes of judgment, and makes still more questionable the propriety of mixing the results of like and unlike stimuli together into general averages, in these so-called memory experiments.

The next questions that naturally arise are:

1° Is the excess of about ⅓ wrong judgments in the experiments with distraction for differences of 8 or 4 vibrations to be attributed to any particular forms of distraction?

2° Is there any correspondence between the reagents' estimate of the depth and absorbing power of a given distraction and an increase in wrong judgments? Tabulating the instances where D was accompanied by an increase or a decrease of right judgments, or where no change took place, we find for the several values of Δ and for the several kinds of D the following table.

An effect of distraction apparent in the following table is more noticeable in this: it is that distraction affected differences of 8 and 4 vibrations about equally; for 4 reagents with 5 forms of distraction a difference of 8 vibrations resulted in 8 instances of increase and 11 of decrease in the percentages of right judgments, and a difference of 4 in 9 instances of increase and 10 of decrease. For six reagents with the first 3 forms of distraction, the corresponding figures for $\Delta = 8$ and $\Delta = 4$

TABLE VII.

Increase (in.) decrease (de.) and equality (eq.) in percentage of right judgments in distraction comparisons.

	REAGENTS B. & G.									REAGENTS L. W. A. S.									TOTAL REAGENTS B. G. L. W. A. S.								
	±8			±4			0			±8			±4			0			±8			±4			0		
	IN.	DE.	EQ.	IN.	DE.	EQ.	IN.	DE.	EQ.	IN.	DE.	EQ.	IN.	DE.	EQ.	IN.	DE.	EQ.	IN.	DE.	EQ.	IN.	DE.	EQ.	IN.	DE.	EQ.
Dist'n Ad.	1	1	0	1	1	0	0	2	0	1	3	0	2	1	1	0	4	0	2	4	0	3	2	1	0	6	0
" Rd.	1	1	0	1	1	0	0	2	0	2	2	0	1	3	0	0	3	1	3	3	0	2	4	0	0	5	1
" Lt.	0	1	1	0	2	0	0	2	0	2	2	0	2	2	0	0	4	0	2	3	1	2	4	0	0	6	0
" M 1.										2	1	1	2	2	0	0	4	0									
" M 2.										1	3	0	2	2	0	0	3	1									
" Hrg.	1	1	0	0	2	0	0	2	0																		
" Den 1.	0	2	0	0	2	0	1	0	1																		
" Den 2.				0	1	1	0	2	0																		
" Den 3.				2	0	1	1	1	0																		

alike, are an increase of 7 and a decrease of ten (10). These figures are not easily intelligible on the basis of a memory-image theory of comparison.

In answer to the first of the above questions, it cannot be said that the distracting powers of any of these forms of occupation was very much in excess of any other. The first series of experiments with the interpolated discrimination of pairs of tones (Den1) gives, indeed, 4 instances of decrease and none of increase, but the last series (with a different norm) gives 3 of increase and 1 of decrease. And here it may be objected that counting the number of instances of increase or decrease is too rough a way to estimate the effects or accompaniments of distraction, and that the amount of effect as expressed in each percentage should be taken into account. But W., to take one of many examples, drops from .93 to .78 for a difference of 8 vibrations with the distraction M^2, but rises for the same distraction from 66 to 68 for a difference of 4 vibrations. The variations of the percentages are too great to permit any comparison of them in pairs; but by lumping all the results for all kinds of distraction and for all reagents together we get figures which, if they have no worth as absolute values, illustrate, in all probability, the general trend of the accompaniments of distraction. A further objection might be raised to the effect that a careful determination of the type to which each reagent belonged should have preceded the experimentation. It is a fault of the investigation that not enough attention was given to the observations of the reagents on the mental process in play during the intervals. On the other hand, there was the danger with comparatively new and very conscientious re-

agents, of stimulating introspection to an extent that would have prevented all regularity in judgment. However, the experiments were in part undertaken to determine what sensory or motor vehicle, if any, existed which carried over the memory image of the first sound to the moment of comparison with the second. To this end we used such a 'drag-net' form of distraction as intoning interesting reading to act at once on any form the memory image might take, together with special aim at the "Mitsingen." In contrast with this was the purely special form of discriminating between tones, which was, of course, designed to act on the acoustic or rather auditory form of memory image. Between the two, with no especial sensory or motor disturbances, lay one of the most efficacious forms of distraction—listening to interesting reading (Hrg).

The question as to the agreement between the subjective impression of the depth or absorbing power of a given abstraction and the decrease in the percentage of right judgments is also to be answered negatively. Beginning with the intonation of interesting reading as the most absorbing form of distraction, next in order came reading letters of words read backwards, and last and least the counting of metronome beats M^1 and M^2. As the discrimination of pairs of sounds affected only 2 reagents we shall consider them separately. Tabulating the results for the 4 reagents L., W., A., S., who were acted on by the above 5 forms of distraction, we find for $\Delta = \pm 8$ and ± 4 the following instances of increase (in.) or decrease (de.) in percentages of right cases as compared with intervals without distraction.

	Rd.	M_2	Ad	Lt.	M_1
in.	3	3	3	4	4
de.	5	5	4	4	3

There is very little indication here of any correspondence between the depth of absorption and decrease in accuracy of judging. The most absorbing form of D—reading with intonation (Lt), is accompanied more often with an increase in percentage of correct judgments than the least absorbing form, of counting metronome beats at the rate of 1.5 a second. No very great amount of significance can, however, be attached either to the relative or absolute values of these figures; it might happen that experiments with more reagents or more experiments with the same reagents would change the order of the series. But there is very little probability that, except by chance, the figures would ever show even an approximate correspondence between the amount of subversion of judgment and the subjective estimate of the depth of distraction.

As was remarked above, the $\Delta = 0$ comparisons show the effects of distraction much more strongly than the differences

8 and 4, and a more decided answer to the question in regard to the correspondence of depth of distraction and subversion of judgment might reasonably be looked for in these cases. The following table gives the increase (+) or decrease (−) of the distraction judgments for $\Delta = 0$ reckoned in per cents of the undistracted intervals.

TABLE VIII.

Decrease in percentages of correct judgments with distractions for each reagent in $\Delta = 0$ comparisons.

Reagents.	Differences in % for the several forms of distraction $\Delta = 0$.							
L.	M^2 −79	Lt −76	M^1 −44	Ad −40	Rd −36
W.	M^1 −47	Lt −40	Rd −15	Ad − 2	M^2 0
A.	M^2 −40	M^1 −33	Lt −17	Ad −15	Rd −14
S.	Lt −70	M^2 −50	M^1 −33	Ad −32	Rd 0
G.	Lt −62	Rd −35	Ad − 0	—	—
B.	Lt −25	Rd −19	Ad −15	—	—

We have here the somewhat unexpected result that the counting of metronome beats (M_1 and M_2) which is the least absorbing form of distraction, together with the intonation of interesting reading (Lt) which is the most absorbing, seem to have the strongest subverting effect on the judgments, whilst adding (Ad) and reading letters backwards (Rd) have the weakest.

From the memory image standpoint, it does not add to the intelligibility of the situation that M_1 had the strongest, and M_2 the weakest subverting effects on the judgments of W. A further consideration of these results will occupy us in the special discussion of the $\Delta = 0$ judgments; here we have simply to remark that in the cases where distraction seemed to have the strongest influence, there is no congruence between the degree of distraction and the subversion of judgment.

The experiments with discrimination of interpolated pairs of clangs as distraction were carried out with two reagents only—S. and B., but at a considerable length. Three (3) main norms 640, 660 and 768 were used, and three minor or distraction norms 620, 528 and 880, for which Δ also had the values ± 8, ± 4 and 0. To the 10, 20, 30, 40 and 60 second intervals were applied respectively 1, 2, 3, 4 and 6 pairs of distraction judgments; thus with the interval of 60 seconds, after the main norm came 6 pairs of successive clangs, each pair of which was to be compared in respect to pitch and the judgment noted. Then came the D or main variable clang which was to be compared with the first of the series. The general results of this experimentation have already been given in Table V; in Table IX we give the detailed results for each time interval.

TABLE IX.

No. of right, wrong, like, and doubtful judgments for norms 640, 660, 768, without and with distractions due to discriminating between pairs of sounds. For each time interval and for each reagent 40 judgments with and 40 judgments without distraction. Differences of main norm and comparison ± 4 vibrations.

	REAGENT G.								REAGENT B.							
	No D.				D.				No D.				D.			
	r	w	lll	o	r	w	lll	?	r	w	lll	?	r	w	lll	?
10 sec.	25	7	8	0	18	13	9	0	20	12	8	0	18	9	13	0
20 sec.	23	11	6	0	23	6	11	0	21	12	6	1	23	10	7	0
30 sec.	22	13	5	0	22	12	6	0	27	11	2	0	20	15	5	0
40 sec.	22	9	9	0	20	10	10	0	21	15	4	0	17	10	13	0
60 sec.	21	12	7	0	22	9	9	0	22	13	5	0	18	11	11	0
Totals,	113	52	35	0	105	50	45	0	111	63	25	1	96	55	49	0

Taking the 'r' cases exclusively we find that G. lost with distraction, for intervals of 10 and 40 seconds—held her own for 20 and 30; and gained for 60. B. loses for all r intervals except for 20 seconds. But if we take the decrease in wrong cases as our guide we find that G. loses twice with distraction and gains 3 times, whilst B. loses once and gains 4 times. If we distribute the 'like' judgments equally between the right and the wrong, we get about an equal number of right cases for each reagent with and without distraction. But it is doubtful if we have any right to make any such distribution in experiments of this kind. The assumption on which such a procedure rests is that the constant and variable errors are similar in kind and in distribution for the equal and unequal stimuli, an assumption, which, as has already been shown, is far from being correct for this form of comparison. Beside the disproportionate increase in wrong cases in passing from unequal to equal stimuli, there is to be added a contradictory tendency in the like judgments according as they are applied to equal or unequal stimuli. G., for example, shows a tendency to underestimate the second tone for objectively like cases, and to overestimate it when the norm and variable are unlike. In some of the preceding tables the likes and doubtful judgments have been distributed between the right and wrong cases, for the sake of comparison with similar tables in other investigations, but the writer feels that the warrant for applying the general procedure in the method of right and wrong cases to experiments of this kind has yet to be shown.

The results of the experiments with distraction reflect very fairly the different opinions of different psychologists in regard to the effects of attention during the time interval. Wolfe

inclines to the belief that the accuracy of comparison depends in great measure on the exertion of attention during the interval,[1] though he remarks cases where no trace of the first tone seems to be present for the attention to act on. Lehmann, on the other hand, found that his reagents could discriminate better between gray disks if they did not concentrate their attention on a memory image in the interval.[2] Hamlin finds that the application of attention to the first stimulus during the interval is more likely to distract than to fix the fading memory image.[3] Radoslawowv concludes that a distraction of of attention during the time interval actually increases the "sharpness" of memory for lines, and his explanation of this result is that by repeated reproductions of the norm the memory for it becomes 'blunted;' when, however, the mind is otherwise busied in the interval of comparison the original impression remains fresh, and its reproduction through the associative action of the second stimulus can take place with greater ease and accuarcy.[4] In view of this explanation it is not going too far to say that had Radoslawowv's results shown an increase of accuracy with attention directed to the memory image of the norm, the effect would have referred to the law of repetition. So plastic, to paraphrase Clifford, is psychological explanation when it has physiologic clay for its wheel. But with one form of distraction in particular, Radoslawowv found a marked decrease in accuracy, and this was where a line was exposed shortly before the variable and differing from it by a value not far from the liminal difference. The decrease in accuracy through the interpolation of this line, Radoslawowv refers partly to 'mistaken' comparisons of variable and distracting lines, and partly to a blotting out of the image of the norm. As this form of distraction is analogous to that used by us in our last series of experiments, it may not be out of place to examine Radoslawowv's work somewhat in detail. Using 2 reagents, a norm of 30 millimeters, distraction distances varying from 26 to 34 mm. and a minimal change of 0.5 mm., Radoslawowv found, *e. g.*, that the intervening line disturbed the comparison in the case of reagent Seyfert, so long as it differed from the norm by about 0.8 mm.—the value of the liminal difference for the reagent. It cannot, however, be said that the method of minimal changes was used by R. in a legitimate way, for the 'steps' of the variable were anything but minimal; in the case

[1] Phil. Stud. III, S. 559.
[2] Phil. Stud. V, S. 127.
[3] Alice J. Hamlin, Attention and Distraction, *Am. Jour. Psy.*, VIII, p. 53.
[4] Radoslawowv Hadji-Denkow, Unt'sg'n ü. d. Gedächtniss f. raümliche Distanzen des Gesichtsinnes. *Phil. Stud.* XV, S. 366.

of reagent Möbius (p. 400), for example, in 9 sets of experiments out of 18 the minimal change was 0.5 mm., the maximal difference was 0.5 mm., and the mean variation zero, which means that the reagent noticed a change with the very first step in half of the experiments, and that this step was noted as "minimal." In the case of the other reagent, in 34 sets of experiments (10 determinations of the liminal difference to an experiment) the variable was moved 4 steps in 3 sets, 3 steps in 16 sets, and 2 steps in 15 sets. This is hardly more than a travesty on the method of minimal changes. Granting that the method was carefully used, it is hard to see how the introduction of a single line between norm and variable could lead to anything but a series of comparisons somewhat after the method of mean gradation. The writer surmises that Radoslawowv would have had fewer cases of mistaken comparisons had he used pairs of lines for filling the time instead of the mediating single line. How this investigator distinguishes between cases of blotting out of the norm, and false comparison is not clear; the evidence for it, so far as we can see, is deduced from the figures and is not given by introspection.

The main conclusion to be drawn from the distraction experiments is that judgments of tone discriminations can take place, and in the majority of our experiments did take place, without conscious comparison between the present sensation and a memory-image of a past sensation. When, for example, a reagent, after a long time-interval filled with interesting reading, from which he had to be practically aroused by a sharp signal in order to prepare himself for the apprehension of the second tone, nevertheless delivered a judgment with a feeling of considerable security, it is idle to speak of 'memory images' or indeed of comparison in the ordinary meaning of the word. Or when a reagent, after having accurately discriminated six pairs of tones, decided with ease that a tone just given is like or unlike a tone 4 vibrations higher or lower sounded 60 seconds before, and is correct in these decisions 63 times in 100, it is evident that the ordinary theories of tone comparisons need readjustment.

No more is it explicable on the theory of memory comparison that there should not have been a great increase in doubtful judgments in passing from undistracted to distracted discrimination, or indeed in failures to judge at all, or that the several forms of distraction should not have shown a far greater difference in effect than was actually the case. Both introspection and the numerical results in our work point to the form of discrimination which we may term *free judgments* (as opposed to 'bound')—the kind commonly given in ordinary life when we speak of a heavy book or a tall man, etc. Martin and Müller have shown that such a form of judgment existed in their ex-

periments with weights;[1] this form of judgment they call 'absolute,' but we think the term 'free' is probably better for psychological purposes, being already in use for the phenomena of reproduction. This matter of free judgments we shall discuss later in connection with the consideration of the 'like' cases. Meanwhile, it may be worth while to examine more critically than has so far been the case, the value of the memory-image theory as an explanation of discriminative judgment.

2. Memory Image Theory of Discrimination.

What may be called an authoritative statement of the memory-image theory is to be found in A. Lehmann's second research on Recognition.[2] Noting in the comparison of two stimuli, the tendency to overestimate the second, he says: "In the act of comparison the second sensation is always compared with the memory image of the first, and inasmuch as the memory image must be fainter than the present sensation, the latter will be estimated proportionately stronger: *i. e.*, it will be overestimated. As the memory image sinks towards zero with the increase of time elapsing between the two sensations, the more pronounced will be the overestimation of the second sensation."

Lehmann found, however, that the theory was not strictly confirmed by his own experiments on memory for sounds—the sound image, after 6 seconds, for example, "having come back almost to its original strength,"[3] so he falls back on the hypothesis of periodic phases of the memory-image. The additional contradicting fact appearing in his experiments, of the frequent underestimation of the second stimulus, he makes no attempt to explain, and the details which he gives, both in the matter of results and of the conditions of experimentation, are too scanty to enable one to form a fair and intelligent criticism of the work. It does not appear, however, that he became aware of these fluctuating memory images through introspection, or that he made any attempt to show them directly; as in the case of Wolfe, their power seems to have been implicitly inferred —on the basis, probably, of the apparently self-evident proposition, that a judgment involving comparison must come from an act of comparison in which the things compared are present in consciousness.

When we come to extend the notion of a vanishing or fading memory image to other characteristics of sensation and especially to qualities of sensation, it is not clear what is meant by fading or changing, and indeed we find here a reflection of the

[1] Martin and Müller. Anal. d. Unt'demp'k't. S. 43.
[2] A. Lehmann: Krit. und experiment. Studien ü. d. Wiedererkennen. *Phil. Stud.* VII, S. 205.
[3] *Op. cit.*, S. 207.

contradictions in respect to the accuracy of sensory memory noticed in our first article. Thus, it has been deduced that the memory image of a light sensation may fade either towards black or towards white[1] or towards a mean or type.[2] In the matter of memory for colors the question becomes more complicated. Does fading or growing dim here imply a decrease in saturation or a drift towards an adjacent part of the spectrum? Does the memory image for red fade towards pink or cherry, or is it towards orange or purple?

Does the memory image of the first of two successive tones fade towards the high or low end of the tone series, or does it merely fade in intensity and so seem to drift towards low? Turning to Table X we find, for example, for the last reagents

TABLE X.

Distribution of 'like' (111), *'higher'* (h), *'lower'* (1), *and doubtful* (?) *judgments with and without Distraction for reagents George and Bullock.*

Vibrations.	G.										B.									
		No Distraction.				Distraction.						No Distraction.				Distraction.				
		111	h	1	?	111	h	1		D		111	h	1	?	111	h	1	?	D
540	=	24	5	6	—	24	3	9	69	67	=	28	6	2	—	23	7	5	1	78 65
	h	2	63	9	3	6	56	6	84	82	h	17	56	2	—	11	42	9	—	75 68
	l	15	3	43	1	1	5	76	70	93	l	4	2	53	1	5	5	61	1	89 85
560	=	17	7	12	—	11	13	12	47	31	=	29	1	6	—	24	8	4	—	81 67
	h	4	55	13	—	7	52	13	76	72	h	6	54	12	—	7	55	8	—	75 79
	l	8	4	59	—	2	3	67	83	93	l	19	3	50	—	9	6	55	—	69 79
576	=	18	9	9	—	7	7	22	50	19		27	6	3		18	7	7	4	75 56
	h	5	49	18	—	5	42	25	68	58		3	57	11		9	46	14	3	80 66
	l	4	3	65	—	5	14	53	90	74		5	12	56		13	8	49	2	77 69
640	=	17	6	13	—	15	5	14	47	44	=	15	7	13	1	10	11	7	8	43 39
	h	14	39	19	—	13	36	23	54	50	h	7	55	9	1	2	60	6	1	77 88
	l	3	9	59	—	13	13	52	83	67	l	5	31	34	—	7	10	38	4	49 68
640	=	7	11	14	—	5	15	12	22	16	=	13	9	10		17	12	3	—	41 53
	h	5	45	14	—	9	47	8	70	73	h	1	55	8		5	53	6	—	86 83
	l	9	6	49	—	8	22	34	77	53	l	6	10	47	1	11	24	26	1	74 43
660	=	8	7	5	—	7	6	7	40	35	=	8	5	6		8	9	3		42 40
	h	8	18	4	—	8	13	15	45	36	h	4	29	7		6	31	3		72 77
	l	5	4	31	—	14	7	23	78	52	l	3	8	29		11	7	22		72 55
768	=	7	4	9		5	3	12	35	25	=									
	h	5	18	17		10	17	13	45	43	h									
	l	7	6	27		7	5	28	68	70	l									

[1] Münsterberg: *Psy. Rev.*, p. 4.
[2] Leuba: *Am. Jour. Psy.*, Vol. V, p. 382.

B. and G. (without distraction) that:—

With reagent G.,

Norm–h was judged "lower" 104 times or 23% of 'h.'
Norm–l was judged "higher" 35 times or 8% of 'l.'
Norm–h was judged "like" 43 times.
Norm–l was judged "like" 57 times.

With reagent B.,

Norm–h was judged "lower" 49 times or 12% of 'h.'
Norm–l was judged "higher" 66 times or 17% of 'l.'
Norm–h was judged "like" 38 times.
Norm–l was judged "like" 42 times.

In each reagent, therefore, the memory image must have drifted in each direction; in the case of G. with a prevailing tendency towards the higher end of the tone series, and with B. towards the lower end,—both reagents being wholly unaware of these processes. Now the nature of tone stimuli is such that we cannot adopt the elastic explanation advanced by Münsterberg in explaining similar results with shades of gray, *i. e.*, that the memory image faded either way according to the positiveness of the impression—a light shade being more positive for some reagents, and a dark shade for others. For in the series of tones judged by these reagents, reaching from 540 to 768 vibrations, it can hardly be said that one tone was more 'positive' than another, nor in the series of tone sensations is there the analogue of the assimilative and dissimilative processes which makes possible such an explanation as Münsterberg's. But according to the memory-image theory the above figures would indicate:—

1° That the memory image for G. faded more strongly towards 'low,' and for B. more strongly towards 'high.'

2° That the memory image of G. acquired such an impetus in fading, so to speak, as carried it beyond the region of 'likeness' more often than merely up to this region.

3° That the memory image of G. had different and opposing tendencies of fading according as the variable was like or unlike the norm.

An obvious explanation of the above figures is that G. simply miscalls perceived differences; he perceives the difference 'norm-high' but calls it 'lower.' But, as against this, in cases where we should expect to find any such tendency most pronounced—*i. e.*, in perceived differences of objectively like cases, the tendency, so far as it exists at all, is rather in the other direction. A discussion of this question will occupy us later on.

It may be said, and has been said, that the memory image neither increases nor decreases in size or intensity, nor changes in quality, but simply becomes dim and indistinct. If any intelligible meaning is to be given to these words, the result of

this growth in dimness and indistinctness would not be a larger liminal difference for the method of minimal changes, or a greater number of wrong judgments for the method of right and wrong cases, but rather a greater mean variation in the former method, and an increase in doubtful cases in the latter, and in both methods an increase in failures to judge at all.

Our tables, however, show no such result; L. who is the most accurate and S. the least accurate in judging objective differences, have the smallest number of doubtful cases. With A., who used the 'doubtful' category more often than any other reagent, we find, indeed, that the maximum number of "doubtful" judgments is with the 60-second interval, but on the other hand the 3- and 5-second intervals together evoke more doubtful judgments (12) than 30 and 40 seconds taken together (9).

Perhaps the simplest conditions for discussing this question are to be found in the case of toneless sounds, such as are given by the sound-pendulum, or better the fall-phonometer used by Starke in his experiments on the measurement of sound intensities.[1] Starke bases his explanation of the different results obtained in the time order on the fading memory image. "If the judgment is given," he says, "immediately after the impression of the second stimulus, the latter will be perceived in its immediate intensity, whereas the first sound being merely in the field of consciousness, can be compared only as a memory image with the second. But inasmuch as the memory image of weaker intensity as compared with the immediate impression, the influence of the time order must show itself in the over-estimation of the second sound.[2]" Turning to Starke's tables we find an extraordinary difference in the figures of the two time orders. Starting with positive or negative supraliminal differences Starke pushed the variable along, step by step, through the region of like judgments until a liminal difference was noted. Taking an 'ascending' variable, where the variable, at first noticeably weaker than the norm, is increased till it is like the norm, we find for three norms in the middle of the series investigated, the following differences

Intensity of Norm (mm.)	Intensity of Variable appearing like Norm (mm.)			
	Reagent Lt.		Reagent Lz.	
	Time order N—Variable	Time order V—Norm.	Time order N—Variable	Time order V—Norm.
200	85	209	87	223
300	176	344	137	316
400	253	408	212	417

[1] Starke, Die Messung v. Schallstärken, Phil. Stud. III, S. 262.
[2] *Ibid.*, S. 290.

in time order.[1] From the above table we are to infer, therefore, that the memory image faded with such great rapidity in the time order norm-variable that the sound of a ball falling 200 mm. appeared no stronger after an interval of less than one second than that of the succeeding ball falling 85 mm., *i. e.*, the first sound must have lost about 57% of its original intensity. It further appears that when the time order variable-norm was used, the first sound faded comparatively slowly—so slowly that at the end of the time interval the variable 209 appeared like the norm 200; *i. e.*, the variable had 'faded' only to the extent of less than 5% of the norm. It might be said that in the second case the attention was directed more closely to the variable, *i. e.*, the first sound—than to the norm, and that therefore the former was held more strongly in the focus of consciousness. Martin and Müller have shown in experiments with 'hefted' weights, that a change in the direction of attention from the second to the first stimulus changes the tendency of judgments,[2] and it is not to be denied that some such influence may have been in play here, though it is not probable that the change of attention would have effected so great a difference as is indicated by the above figures. Starke himself gives no account of the attitude of his reagents in the two time orders, or indeed whether they were aware of the change in order, but in the figures which show the results of the descending gradations, *i. e.*, of the decreasing variable—we find conclusive evidence that the discrepancy in 'fading' in the two time orders is not due to a change in the direction of attention. From the same tables that gave the preceding figures, we take the results which Starke found by starting the variable somewhat louder than the norm, and then decreasing it till it appeared like the norm.

Intensity of Norm (mm.)	Intensity of Variable appearing like Norm (mm.)			
	REAGENT Lt.		REAGENT Lz.	
	Time order N—Variable	Time order V—Norm.	Time order N—Variable	Time order V—Norm.
200	169	394	160	387
300	279	578	256	582
400	374	747	352	744

In the case of reagent Lt. "like" for a norm of 200 was reached at a height of 169—indicating a comparatively small amount of fading. With the variable coming first, however, "like" for the same norm 200 is reached at a height of 394—

[1] *Ibid.*, S. 289.
[2] Martin and Müller: Analyse der Empfindlichkeit. S. 185-196.

a loss in intensity according to the hypothesis of 97% of the norm, so that in this case, if the attention was directed chiefly to the variable, it only served to accelerate its fading.

In strong contrast with Starke's results Kämpfe[1] found a very small time error for each of his two reagents. Moreover, whilst one reagent generally overestimated the second sound, the other underestimated it. Like Starke, Kämpfe worked with toneless sounds, though produced by the sound pendulum and not by the sound phonometer. Both investigations were carried out in the same room, and according to the memory image theory should have produced similar results. Kämpfe states the memory-image theory of the time error and suggests that the results, contradictory of the theory, may have been due to a strong fixation of the first sound.[2] He lays no weight on the explanation, however, but points out that the contradiction exists, and that the further discrepancy in his own judgments, where he passes from under to overestimation of the second stimuli, is not in disagreement with Fechner's experiments.[3] It was also found in the experiment on the method of mean gradations alluded to above (p. 61, note) that the two reagents showed contrary tendencies in estimating the position of the middle stimulus in the two time orders.

In the method of mean gradation or supraliminal differences, more perhaps than elsewhere, any theory of the comparison of impressions by means of the waxing or waning memory images becomes a tangle of absurdities. According to such a theory, in comparing three successive impressions, a, b, and c, we hold

NOTE. The explanation of the above discrepancies is to be found in a complication of factors which have themselves become subjects of psychological investigation, but which at the time these experiments were carried out [1883-1889] were hardly surmised. The influence of two of these factors, *i. e.*, the point of departure of the variable, and the size of the steps in a gradation method were subsequently pointed out by the writer, working under the same experimental conditions as obtained in Starke's research. [F. Angell. Unt. ü. d. Schätzung von Schallintensitäten, etc. *Phil. Stud.* VIII, S. 446-448.] Starke's tables give the impression that the point of departure for the variable, and the size of the 'steps' were closely proportional to the value of each norm used—conditions which would result in about the same number of judgments for all values of the norm. The writer would not here be understood as implying that such a procedure would invalidate Starke's results either as regards Weber's law, or the proportionality of sound intensity and height of fall, but it is to be inferred that the liminal values obtained by Starke (8 to 9 % of norm), hold good only for the particular conditions under which the experiments were performed.

[1] Kämpfe: Beit. z. exp. Prüf. d. Meth. d. r. und f. Fälle. *Phil. Stud.* VIII, S. 562.
[2] *Ibid.*, S. 583.
[3] Fechner: *Psychophysik*, I, S. 90.

a and b first as memory images till c comes along, and then we compare the 'distance' a-b with b-c. In the first place there appears no reason why the memory-images of a and b should not coalesce; as they are supposed to exist simultaneously in the mind, they must coalesce. Supposing, however, they could be kept apart, we find that we have to compare the 'distance' a-b with b-c, when a-b is the distance between a remote and a near memory image, and b-c the distance between a near memory image and a present sensation.[1] But of all this complicated comparison of central and peripheral sensations, but little trace is to be found either by way of inference from the figures of the different time intervals, or directly from introspection. When three successive sounds, a, b, and c, are given at short intervals and b is judged 'nearer' a than c, the sound c seems in the moment of judgment no less a perception and no more a memory image than a—introspection usually failing to find any trace of imagery except perhaps a more or less disturbing visual scheme of the 'distances.'[2]

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[1] *Op. cit.*, S. 463.

[2] The term 'distance' is, of course, a figurative way of expressing degree of likeness or similarity. If the sounds a, b, and c are given, a and b coming from stimuli which are much nearer together than b and c, then we 'judge' that b is more like a in respect to intensity than like c, or figuratively, that the 'distance' a-b is less than b-c. It is to be observed that such a judgment can be given directly and immediately, without training and without reflection, by any one, child or adult, who is capable of discriminating between the sounds and holding them in mind. When, however, b moves towards c the difficulty in delivering a judgment increases, until it becomes exceedingly hard to say whether b is nearer a or c, or equidistant from both. This is a difficulty which is inherent in all psychophysical measurements and is not to be overcome either by experience or by reflection.

But besides this direct and so to speak, natural way of comparing three successive stimuli, Julius Merkel, in order to explain the discrepancy between his results and my own, has attributed to the reagents of my experiments, a power of comparing the several impressions according to their ratios, and this comparison according to ratio [Verhältniss] plays a most unimportant part in general in his explanation of results obtained by the method of mean gradations. Now it is obvious that the reagents could have given themselves over to comparing the three stimuli according to the arithmetical mean, geometrical mean, the golden mean, or any other ratio which they could have held in mind; but if introspection has any value as evidence, they did not. They started out in a series of experiments with the judgment that b, *e. g.*, was more like a in respect to intensity than like c; this is a direct and primary relation of similarity, and has no more to do with a comparison of intensity ratios than has the judgment that peaches taste more like apricots than like plums. In other comparisons, b seemed more like c than like a, and in some cases the reagents could not say whether b was more like c or like a in respect to loudness or intensity. Sometimes, not often, they had the conviction that b resembled a in respect to intensity just as much as it resembled c, or figuratively, that b was midway between a and c. These are the plain

In Bentley's[1] work on the optical memory image, the image was voluntarily produced as far as possible after a signal given just before the variable was exposed—the purpose of the research being an investigation of the qualitative 'fidelity' of the voluntarily aroused central ideas. But even under these conditions it was found that 'free' judgments, *i. e.*, judgments in which introspection failed to find a trace of comparison with a memory image, were given quickly and with a feeling of considerable security. The memory image itself Bentley found more easily producible at the end of five minutes than of one minute.

In Radoslawowv's investigation on memory for lines we find a good example of the elasticity of the memory-image theory. In the earlier part of Radoslawowv's extended research he asserts, very emphatically, that it is impossible for the attention to be directed during the time interval to the memory image, as the image is rarely present, and when present, is indistinct.[2] But further on, as has been already remarked (p. 68), we find R. explaining the more accurate results obtained when the time intervals were filled with some distracting occupation, on the hypothesis

facts in the case, and if Merkel desires to call this way of comparing, a comparison by ratios, he is of course free to do so. But if by this he means that the reagents tried to compare the stimuli in such a way that a should be to b, as b to c, I am bound to say, first, that the reagents gave themselves over to no such artificial scheme, and secondly, had they done so the results could not have been regarded as valid any more than Merkel's own results with his method of double stimuli—and for the same reason,—they would have been the outcome of reflection and inference from experience. As regards Merkel's remarkable assertion that I found the geometrical mean of the stimuli because I had to find it (*Phil. Stud.* X, S. 212), I am free to say that beyond a slight weakness for the arithmetical mean because it is easier to calculate, I find in myself no marked tendency towards either mean—assuredly no such compulsive force as would have driven me for about 2 years through the not highly exhilarating exercise of dropping ivory balls on ebony plates in a hunt for a geometric mean. Why, if Merkel felt that from the first the work was predestined to the state of the geometric mean, he should have given so many pages to combating it, is not clear to me. Inasmuch as Merkel's objections are partly errors of comprehension, and mostly matters of small psychological moment, I have not thought that psychological research would be benefited by a detailed discussion of them. The main question at issue in the controversy is one of method, and to such psychologists as have the patience to wade their way through Merkel's investigations and my own, I am more than willing to leave the decision as to the way in which trustworthy results are more likely to be obtained—from a series of regularly graded stimuli which the experimenter presents to himself as reagent, or by an irregular series presented to reagents who have no knowledge either of the objective value of the stimuli, or of the trend of results.

[1] Bentley: The Memory Image and its Qualitative Fidelity, *Am. Jour. Psy.*, XI, p. 1.

[2] *Op. cit.*, S. 355.

that during the empty intervals the memory was 'dulled' by the incessant reproduction of the normal line, just as the memory image of a face fades the more, the longer the attention is directed to it.[4] On p. 396 again, we find that the inaccuracy resulting from introducing a distracting line between norm and variable is referred to the expunging of the memory-image of the norm by the intermediate line. In general, however, in these experiments of Radoslawowv, the writer is of the opinion that what has been investigated is not the 'sharpness' of memory for lines but rather the accuracy of comparison under circumstances of increasing difficulty, *i. e.*, increased intervals of time. For in the table which give the results of R.'s experiments with the method of minimal changes, we find that two of the three reagents (F. and E.) showed an increase in liminal difference values for the upper limina, for an increase in time interval, but failed to show any corresponding increase in the mean variation; in both cases the mean variation indicated small and irregular fluctuations. We are able to form no intelligible theory of comparison through an act of memory which would explain such figures; waxing or waning, fading or brightening of the first impression would all have given different results from the above. But similar results could have been obtained had the reagents compared simultaneously lines placed at increasing distances from one another. In such a case the liminal differences would have increased with the increase in distances between the lines exposed; and had the reagents waited till they felt the same degree of security for each liminal difference, the result would have a small and irregular fluctuation in the mean variation. They might, however, have recorded their first more or less insecure impression of a liminal difference; in this case the liminal value would not show much growth, but the mean variation would increase with the difficulty in comparison. This condition actually obtains in the lower liminal values for the two reagents F. and E. The writer regards this only as a possible explanation of these contradictory results; but the conventional scheme of memory comparison is here impossible. Experimenting on himself and using the method of right and wrong cases, Radoslawowv found in general a decrease in right judgments along with increase in time interval; for the time intervals running from 1 sec. to 13 sec. the decrease in right judgments was 65.3 to 46.3%.[1] For the same range of time intervals, *i. e.*, 1 to 15 seconds, Wreschner, using an irregular method of minimal changes, found little or no falling off in sensitiveness to differences for linear distances.[2] So far as such results concern the conventional scheme of sensory memory

[1] *Ibid.*, S. 366.
[2] *Op. cit.*, S. 339.
[3] Wreschner: Meth. Beit. z. psychophys. Messungen, S. 231.

they are, of course, contradictory, but so far as they indicate the varying influences of different psychophysical methods they are in themselves interesting subjects for psychological investigation.

The writer has gone at some length into the memory-image theory of comparison because he considers that it has had an exceedingly harmful influence on psychological research. As Külpe says:[1] "It is remarkable that this theory should have maintained itself up to the present time, whilst the contradiction in which it involves the facts of experience, as well as any consistent explanation of these facts, have rarely been noticed." It was unfortunately launched with all the impetus that comes from Fechner's authority, though Fechner seemed well aware of its contradictions, and it still continues to glide along over logical inconsistencies and psychological absurdities. Its powers of adaptation are shown in Wreschner's argument against Külpe that although we are not aware of the presence of the memory image of the earlier impression in an act of comparison, "still the first impression can be regarded as artificially held in remembrance. and passing over into the second, when it undergoes a change which can be regarded as the source of the time error.[2]" If it be objected that in this article, the fading or waning of the memory image has been interpreted in too much of a physical sense, it is to be replied, that this is precisely the trouble with the theory—it is a concept derived from physical processes with physical implications on which have been grafted the determinations of the psychophysical measurements, the outcome of which has been barren of all results for psychology.

An example of what an elastic memory-image theory with physical implications can accomplish is to be seen in Warren and Shaw's "Memory for square size[3]" in which we find not only a fading memory image, but a play of imagination images taking place according to the laws of chance, and under the dominating influence of Weber's law—which process goes on until the 'average imagination image' usurps the function of the memory image and brings about an overestimation of the norm. But of all this complication of waxing and waning, of fading and brightening of memory images, introspection has found but scanty trace, and when as in the case of optical stimuli the memory image occasionally appears, it has yet to be shown that it increases the accuracy of comparison in so-called memory experiments any more than the possession of an absolute memory for pitch increases discriminative sensibility for tones.[4]

[1] Külpe: Phil. Monatsh., XXX, S. 282.
[2] *Op. cit.*, S. 173.
[3] Psy. Rev. II, p. 241–243.
[4] Vid. v. Kries, Ueb. d. absolut. Gehör, Z. f. Psy. III, S. 262.

THE APPERCEPTION OF THE SPOKEN SENTENCE: A STUDY IN THE PSYCHOLOGY OF LANGUAGE.

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I.

INTRODUCTION.

Despite the important rôle which it plays in the mental life, language has, until recently, received but scant attention from the psychologist. While all have recognized the significance of language both as a medium for the transmission of experience,[1] and as the precondition of the higher 'intellectual' processes,[2] very few have attempted a detailed analysis of the verbal idea, and only within a few years has the psychophysics of verbal expression and verbal perception been adequately exploited. It is true that some of the Herbartians, especially Lazarus[3] and Steinthal,[4] have given the discussion of language an important place in their psychological systems, and it is true that the English school—Hartley,[5] Locke,[6] and James Mill[7] in particular—have made much of the function of the word in conceptual thought. But the Herbartian treatment of language was limited to the part which verbal symbols played as the condensed representatives of the Herbartian 'Ideas;' and the English treatment of language belongs rather to logic and epistemology than to psychology. In the

[1] Wundt, W: Grundzüge der physiologischen Psychologie. Leipzig, 1893, Vol. II, pp. 610 ff. James, W.: Principles of Psychology. N. Y., 1900, Vol. II, pp. 356-358. Hoefler, A.: Psychologie. Wien und Prag, 1897, pp. 537 ff.

[2] Ladd, G. T.: Psychology, Descriptive and Explanatory. N. Y., 1894, pp. 379 ff. Sully: Outlines of Psychology. London, 1885, pp. 337 ff.

[3] Lazarus, M.: Das Leben der Seele. Berlin, 1878, pp. 213 ff.

[4] Steinthal, H.: Einleitung in die Psychologie und Sprachwissenchaft. Berlin, 1881, pp. 290 ff.

[5] Hartley, D.: Observations on Man, 4th ed. London, 1801, pp. 268 ff.

[6] Locke, J.: An Essay Concerning the Human Understanding. Oxford, 1894, Vol. II, Book iii.

[7] Mill, J.: Analysis of the Phenomena of the Human Mind. 2d ed. London, 1878, pp. 127 ff.

earlier literature of the experimental school, the phenomena of language are strangely neglected. The early studies on the association of ideas used the word as a convenient instrument of experimentation, and the related work upon reaction times involved many of the psychological and physiological principles of vocal expression as well as the psychophysics of symbolic perception; but in neither of these instances was language the primary interest. And yet, notwithstanding this early neglect, there has within the past decade been a very promising growth of monographic literature devoted solely to the psychophysics of language as such. If this growth continues at its present rate, the time will come within a very few years when this literature, together with the philological and pathological studies bearing upon the same problems, must be condensed and classified into a true psychology of language. The time is, of course, not yet ripe for such a systematic treatment, but in lieu of the guide which it would afford, the following very brief enumeration of the fields which such a compendium must cover may serve to introduce our own problem, and to give it the advantage of an orientation which, even if tentative and inadequate, will at least be logical.

The general psychology of language divides itself logically into two great sections: (1) the psychology of language considered as the preconditioning mechanism of the higher mental processes; and (2) the psychology of language considered as the medium of communication, through the agency of which experience is transmitted from individual to individual. To the first section belong the introspective studies and analyses of the verbal idea, its composition in terms of sense-modalities and its function in 'thought.' The monographs of Stricker[1] and of Raymond Dodge[2] are examples of the work which will fall under this rubric. The second section includes the great mass of material which deals with word-perception, the psychological unit in reading, speech development, and the phenomena of aphasia, all of which will fall within one or other of two subsections: (a) the psychology of symbolic expression; and (b) the psychology of symbolic interpretation.

The former subsection deals with the conscious processes that are correlated with the expression of symbols, either by gesture, by manual signs, by writing or by speech. It is manifestly a department of the psychology of action, but its problems have hitherto been treated mainly by the genetic or

[1] Stricker, S.: Studien uber die Sprachvorstellungen. Wien, 1880.
[2] Dodge, R.: Die motorische Wortvorstellungen. Halle Dissertation, 1896.

by the pathological method. Among the genetic studies of expression, the work of Baldwin,[1] Preyer,[2] Perez,[3] Schultze,[4] Noble,[5] Kirkpatrick,[6] Tracy,[7] and Lukens[8] furnishes valuable data regarding the ontogenesis of speech. These data must, of course, be verified and supplemented by further observations, and finally interpreted in the light of some comprehensive theory of mental development. In connection with the pathology of expression, the work of Wernicke, Grashey, Lichtheim, Freud, Hughlings-Jackson, Kussmaul, Exner, Charcot, Déjérine, Bastian, Starr, and Elder is too well known to require especial mention. Many of the monographs are already classics in the literature of psychiatry. A general summary of their results, however, interpreted from a psychological rather than from a clinical standpoint, has long been wanting. Perhaps the most satisfactory attempt to fill this want is represented by Joseph Collins's recent work.[9] Bawden's monograph,[10] dealing as it does with the border-line between normal and abnormal expression, will also find its place in this subsection.

The latter subsection—the psychology of symbolic interpretation—deals with the conscious processes that are correlated with the perception of symbols and the apperception of their meaning. It is to this chapter of the psychology of language that the present study belongs. It represents an attempt to determine the nature and relations of the factors which are involved in the perception of spoken symbols and in the apperception of their meaning. Inasmuch, however, as the study was suggested by recent investigations upon the psychophysics of visual perception, a general discussion of the factors involved in any form of symbolic perception, as well as a brief review of these other investigations, will not be out of place.

If we consider symbols apart from their ' meaning ' and look

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[1] Baldwin, J. M.: Mental Development in the Child and the Race.

[2] Preyer: Mind of the Child. Trans. Brown. N. Y., 1888. Mental Development of the Child. Trans. Brown. N. Y., 1893.

[3] Perez, B.: The First Three Years of Childhood. Trans. A. M. Cristie. Chicago, 1895.

[4] Schultze, F.: Die Sprache des Kindes. Leipzig, 1880.

[5] Noble, E.: Child-Speech and the Law of Mispronunciation. *Education*, Sept. and Oct., 1898.

[6] Kirkpatrick, E. A.: How Children Learn to Talk, etc. *Science*, Sept., 1891.

[7] Tracy, F.: The Psychology of Childhood. Boston, 1895.

[8] Lukens, H. T.: A Preliminary Report on the Learning of Language. *Pedagogical Seminary*, Vol. III, pp. 424-460.

[9] Collins, J.: The Genesis and Dissolution of the Faculty of Speech. New York, 1898.

[10] Bawden, H. H.: A Study of Lapses. *Psychological Review Monograph Supplement*, Vol. III, No. 4 (Whole No. 14), April, 1900.

at them simply as different forms of stimuli appealing to one or another of the sense-departments, it is manifest that certain psychophysical principles condition their efficiency for perception. (1) The symbols must over-step the spatial, qualitative, temporal and intensive limina of the sense-department to which they appeal; and (2) the symbolic elements must overstep the differential limen of the modality to which they belong, *i. e.*, they must, as perceptive elements, be discriminably different. In the ordinary visual symbolism, these differences are spatial,—differences of form, of spatial extent, of spatial position. In the typical auditory symbolism—speech—the differences in the expressive stimuli are more complicated. They are (1) a qualitative difference, (2) a temporal difference (both of which may be called primary differences), and (3) an intensive difference (which is more or less secondary in its nature). In more concrete terms, the differences in the symbolic elements appealing to the ear are: (1a) in the case of consonants, modal differences of a complex nature due to the different forms of adjustment and release of the various parts of the vocal apparatus concerned in the production of consonants; (1b) in the case of vowels, simpler qualitative differerences due to the modifications of the laryngeal clangs by the changes in the form of the pharynx and the buccal cavity; (2a) temporal differences within the complex temporal unit of expression (rhythm); (2b) temporal differences in the rapidity with which one symbol element succeeds another symbol element (quantity and pause); (3) intensive differences, due to the fact that certain symbol elements may be emphasized and that the innervation for certain other symbol elements may be weakened.

It is evident that a psychophysical examination of the conditions underlying the perception of symbols must proceed along the lines marked out by an analysis similar to that given above. One of the problems of such an investigation would be the determination of the value of each of these factors in word and sentence perception. This we find to be the point of view of those who have recently approached the study of language from the psychophysical side. They have consistently held to the problem of perception, and they have treated this problem according to psychophysical methods. This work has, however, been confined almost exclusively to visual perception, and the majority of monographs that have been produced are studies in the psychology of reading.

Cattell[1] made the first important experimental determination of the time required for the perception of letters and words. His prin-

[1] Cattell, J. McK.: Ueber die Zeit der Erkennung und Benennung, etc. Phil. Studien, Vol. I, pp. 635 ff.

cipal conclusions are as follows. (1) The maximal rapidity with which a word can be read, when given in a context, varies directly with the subject's knowledge of the language to which the word belongs; (2) if the words do not form sentences, and the letters do not form words, the time required for reading them is approximately doubled; the time required for the perception of a letter is very little shorter than that required for the perception of a word; (3) the less familiar a word is, the smaller is the difference in the time required for reading it backwards and reading it forwards.

During the same year in which Cattell made these determinations, Grashey[1] published a paper, based upon a study of aphasia, in which he maintained that the unit of perception in reading was the letter and not the word. This position was adopted by Wernicke, Leube and other alienists. Loewenfeld,[2] six years later, basing his conclusions also upon aphasic observations, affirmed that with the practiced reader the operation was not literal but verbal. He supported this observation by experiments with blurred words, in which he found that when the words were familiar a considerable amount of blurring did not interfere with the perception, while quite the opposite obtained with unfamiliar words. Goldscheider and Mueller[3] subjected this problem to an elaborate experimental treatment. They found the time of perception to be dependent (1) upon the number of elements, and (2) upon the uniformity of their arrangement. In the case of elements of different kinds, the type or plan of arrangement was much more easily perceived than the separate characteristics of the single elements. In the exposure of letters which did not form words, the following results were obtained. (1) Four letters were correctly perceived upon the first exposure; (2) five letters were always correctly seen upon the second exposure. As regards letter-series forming syllables, words, and word-groups, it was found that series of four letters were correctly read at the first exposure; more than four letters were not successfully read at the first exposure, unless they were quite familiar. If the entire word is not perceived, there is a tendency to fill out the perceived letters into any word that may contain them. In words of eight letters or more, more than one exposure is invariably required. While only eight letters can be perceived in .03 sec., three words that make connected 'thought' can be correctly perceived in the same time. In actual reading, letters are either of 'determining' or of 'indifferent' significance for perception. To the former category belong in general the consonants and especially the initial letters. General conclusions: (1) In ordinary reading, there is no reason to believe that each letter is perceived as such. (2) For the production of the verbal (auditory-kinaesthetic) idea, and for the purposes of conceptual 'apperception,' the perception of the total number of letters uniting to form the word is not necessary, the perception of certain determining letters being sufficient for these purposes. (3) It is probable that the determining letters evoke the phonetic letter-sound images corresponding to them, and that these in turn evoke the complete verbal (auditory-kinaesthetic) image. (4) The word-image procedure in reading is not to be distinguished from 'literal' reading by the perception of 'determining' letters. The word-image is the succession of letter images.

[1] Grashey, H.: Ueber Aphasie und ihre Beziehung zur Wahrnehmung. Archiv für Psych. u. Nervenkrankheit, Vol. XVI. (1885.) pp. 654-689.

[2] Loewenfeld: Ueber zwei Fälle von amnestischer Aphasie, etc. Deutsche Zeitschrift für Nervenheilkunde, Vol. II. I Heft.

[3] Goldscheider, A., und Mueller, R. F.: Zur Psychologie und Pathologie des Lesens. Zeitsch. für klinische Medicin, Vol. XXIII, pp. 130-167.

'Reading in word-images' is, therefore, in reality a reading in letter groups.

Pillsbury's problem [1] was in many respects closely related to that of Goldscheider and Mueller. He attempted to determine the "relative importance of sensation and the more general and remote factors which are involved in the very simple and familiar operation of reading a word." The method employed was the mutilation of type-written words by omitting, blurring and substituting letters. Results: (1) The various kinds of changes made in the words stand in ease of recognition in the following order: omitted, substituted, blurred. (2) A disfigurement of the first letter is easily recognized, but disfigurements coming later are apt to be overlooked. (3) Where more than one letter is disfigured the first disfigurement is not so often overlooked as are the others. (4) There is about as much chance of recognizing a misprint when it stands alone as when others are combined with it in the same word; if there is any difference, it is in favor of recognizing a change when others are present. (5) The strength of suggestion which comes from the word itself is entirely independent of the length of the word. (6) The proportion of misprints overlooked is greatly increased under the influence of the suggestion of associated words.

Erdmann and Dodge [2] consider Goldscheider and Mueller's results untenable. (1) Words are optical wholes, but the spoken reproductions are letter combinations. (2) If a printed line (the context of which may be readily understood) is read, and the head meantime kept in an immovable position, there is a regular alternation between the pauses of rest and the eye movements. The number of movements is much smaller in reading the mother-tongue than in reading a foreign language; and the more familiar the context, the more uniform are the durations of the rest-pauses and the movements. (3) The number of rest-pauses and movements is three times as great when the reader attends to the text itself as when he attends to the contents of this text. (4) When the attention is directed upon the text, rather than the contents, the field of most distinct vision includes about four letters (p. 68). (5) The rapid alternation of the black and white text-elements following one another during the eye-movements completely excludes the possibility that we cognize the letters in the course of such movements (p. 71). During the course of the eye-movement in reading there is lacking a perceptive contents corresponding to the actual stimuli presented by the letters, if, as is ordinarily the case, the attention is not directed to this perceptive contents. (6) Visual perception of the letters in reading occurs exclusively during the rest-pauses of the eye; these can, therefore, be designated reading-pauses. The areas of simultaneous perception in reading are greater than the areas of distinct perception of the single letters, and the range of these reading-areas excludes the possibility that all single letters contained in them are distinctly perceived. The sum total of the visual angles subtended while reading a line is smaller than the visual angle for the entire line. (7) Under similar conditions, four to five times as many letters can be read in word-connection as without word-connection. In the reading of letters exposed without word-connection, the last to be exposed are generally either not read at all or falsely read. (8) The fact that we perceive familiar words under conditions that exclude any perception of the single elements is due to the typical forms which the words

[1] Pillsbury, W. B.: The Reading of Words. This *Journal*, Vol. VII, pp. 315 ff.
[2] Erdmann, B., and Dodge, R.: Psychologische Untersuchungen ueber das Lesen auf experimenteller Grundlage. Halle, 1898.

possess under these conditions; just because the single *letters* are perceptive units only through the arrangements of their component parts, the verbal perception must be dependent upon the type-form that is peculiar to the *word* as an unit of visual perception. (9) The simultaneous perception of short sentences, parts of which are seen only very indistinctly in indirect vision, must involve the co-operation of contextual connections in meaning which render the 'understanding' of the sentence possible. It is, however, not this contextual connection, but the type-form of the word, that gives in general the deciding conditions (p. 175). (10) The spoken and heard words are successive wholes, while the visual word is a simultaneous whole. The spoken word is only imperfectly symbolized by the visual word (p. 191). The spoken word is a whole only in the combination of its acoustic and kinaesthetic sensations.

Quantz[1] found that colors are more easily perceived than geometrical forms, isolated words than colors, and words in connection than disconnected words.

Huey[2] found that the speed in reading aloud is correlated with the 'sense' made. 'Sense' passages are read in a little more than half the time taken for nonsense passages of an equal number of letters. "The pronunciation of an adjective . . . seems to subexcite association tracts representing substantives,—preferably and more strongly substantives with which the particular adjective has been most often associated. . . . The right word is ready to leap out at the slightest suggestion from the printed page, if that passage makes sense." The last part of a word is less essential to the perception of the word than the first part. This may be due (1) to the tendency of the English language to accent the first part of the word, the accented part thus tending to represent the word, or at least, the spoken word; (2) to the preponderance of suffixes over prefixes, the main root of the word being in the first part, and rendering the first part more important. Huey concludes that the theory of letter perception in reading is untenable.[3]

Above all else, this work upon visual perception bears overwhelming testimony to the significance which 'context' has for the perception of symbols which appeal to the eye. It was the primary object of the present study to determine whether a similar condition obtains in the case of symbols appealing to the ear. The experimental consideration of this question furnished material for further study along related lines, so that the final formulation of our problem included three distinct divisions: the primary question (a) What is the effect of 'context' upon the perception of auditory symbols, or, in other words, how are the objective elements of auditory symbolism related to the subjective or central elements?—and two subsidiary questions: (b) How are the objective elements related to one another? and (c) What are the conscious processes involved in the apperception of the spoken sentence?

[1] Quantz, J. O.: Problems in the Psychology of Reading. *Psychological Review*, Monograph Supplement, Vol. II, No. 1, 1897.

[2] Huey, E. B.: This *Journal*, Vol. IX, pp. 574 ff; Vol XI, pp. 283 ff.

[3] For a more detailed analysis of the earlier literature dealing with the problems of word and sentence perception, see Erdmann and Dodge, *op. cit.*, pp. 7-30.

II.

EXPERIMENTS.

(A) THE PERCEPTION OF AUDITORY SYMBOLS: (1) The Relation of the Objective to the Subjective Factors of Auditory Symbolism; (2) The Relation of the Objective Factors to One Another.

§ I. *Method and Apparatus.* The method employed in the first two determinations was based upon the psychophysical principles we have already laid down. A word is normally a definite complex of various sounds which we call consonants and vowels. As we have seen, the consonantal variations are modal changes conditioned by the different forms of adjustment and release of the vocal organs. The vowel variations are qualitative modifications of the laryngeal clangs. A consonant always involves a vowel; hence, if we vary the consonants, we also vary the vowels. Our method involved the elision of consonants, and a determination of the accompanying effect of the word upon the observer. In order to determine the relation of the psychophysical factors to the central factors (the first and primary problem), (a) mutilated words were given without context, (b) mutilated words were given with a minimum of context, *i. e.*, with one or two related words, (c) mutilated words were placed at the beginning of complete sentences, (d) mutilated words were placed in the middle of complete sentences, and (e) mutilated words were placed at the end of complete sentences. In order to determine the value of the symbolic elements as compared with one another, *i. e.*, the relation of the objective factors to one another (the second problem), the effects of the various forms of mutilation upon the perception of the word by the observer were compared. In this case the words were used with and without context, the temporal conditions being varied by eliding consonants (a) at the beginning of the word, (b) in the middle of the word, (c) at the end of the word.

The words thus mutilated were divided into the following categories:

I. Initial consonant omitted. Class A.

II. Mid-consonant omitted. Class B.

(1) The consonant standing alone between two vowels.

(2) The consonant standing next to another consonant,—so, *i. e.*, that a voiceless hiatus should not be left between the vowels upon elision.

III. Final consonants omitted. Class C.

These words were placed in short, complete and categorical sentences, which were classified as follows:

I. Sentences in which the mutilated word is at or near the beginning. Class *a*.

II. Sentences in which the mutilated word is in the middle. Class *b*.

III. Sentences in which the mutilated word is at the end. Class *c*.

There were thus possible the following series of sentences:

Aa. Initial consonant omitted at the beginning of the sentence.
Ab. Initial consonant omitted in the middle of the sentence.
Ac. Initial consonant omitted at the end of the sentence.
Ba. Mid-consonant omitted at the beginning of the sentence.
Bb. Mid-consonant omitted in the middle of the sentence.
Bc. Mid-consonant omitted at the end of the sentence.
Ca. Final consonant omitted at the beginning of the sentence.
Cb. Final consonant omitted in the middle of the sentence.
Cc. Final consonant omitted at the end of the sentence.

Of these possible combinations, the following were selected as answering every demand of the experiment:

Aa, Ac, Ba, Bc, Cb, Cc.

It was attempted to make every series complete, *i. e.*, to represent every consonant in every series. For purposes of convenience a classification of consonants, following in the main that of Whitney,[1] was tentatively adopted:

	Semi-vowels.	Aspirates.	Nasals.	Sibilants.	Spirants.	Mutes.
Labials	w		m		v, f	b, p
Linguals	r, l		n	z, s	th, ch, j	b, t
Palatals	y	h	ng	zh, sh		g, k

It was also attempted to combine every consonant with every vowel; *i. e.*, to represent each consonant in every series by as many different words as there are different vowel sounds. When this could not be done, different words were added in which the consonant in question was preceded or followed by a vowel already in use in another word.

The following complete series (Bc) is inserted as an example:

1. As a companion he was extremely a(m)iable.
2. The howling wind set the windows rattling and the doors sla(mm)ing.
3. The religious spirit is predominantly e(m)otional.
4. It is often hard to reduce a compound to its ele(m)ents.
5. A light on the distant shore was gli(mm)ering.
6. As a boy, the poet was forever rhy(m)ing.
7. He would have loosened the knot in another mo(m)ent.
8. The governor refused a new no(m)ination.
9. He pointed toward where the mountain was loo(m)ing.
10. The greatest life cannot be wrecked by calu(mn)y.
11. The most exasperating being on earth is a coquettish wo(m)an.
12. Of all that little band of men he was the bra(v)est.
13. It was a mystery that none of us could unra(v)el.

[1] Whitney, W. D.: Life and Growth of Language. N. Y., 1885-1897, p. 62.

14. It was admitted to be a glorious achie(ve)ment.
15. He did not deny the possibility of divine re(v)elation.
16. Amusement was furnished in great di(v)ersity.
17. Every man possesses an element of the di(v)ine.
18. He stopped to take breath when he reached the ri(v)er.
19. It was rumored that the war was o(v)er.
20. We knew that he could not reco(v)er.
21. The circuitous route is the sa(f)er.
22. When we saw her she was lau(gh)ing.
23. The captain wore a heavy ree(f)er.
24. I had never seen him be(f)ore.
25. The concussion was dea(f)ening.
26. He was known as an ignorant sco(ff)er.
27. It is wrong that the innocent should su(ff)er.
28. Gluttony is an euphemism for stu(ff)ing.
29. He loved all animate things except ba(b)ies.
30. The word was not in the voca(b)ulary.
31. I had often witnessed the scene he had just been descri(b)ing.
32. He was held for murder and ro(bb)ery.
33. The ring was set with ru(b)ies.
34. The floor needed a good scru(bb)ing.
35. His painting might better have been called dau(b)ing.
36. As a mechanic he was extremely ca(p)able.
37. One cannot deny that the office-holders are ra(p)acious.
38. No one doubts the moral efficacy of re(p)entance.
39. The flocks were watched by she(p)herds.
40. The wire was quickly cut with a pair of ni(pp)ers.
41. Some one cut the rope he was gri(pp)ing.
42. The bank was slo(p)ing.
43. I caught the words he was dro(pp)ing.
44. It was the work of the little god Cu(p)id.
45. Blame no man for his stu(p)idity.
46. The structure was simply stu(p)endous.
47. His position on the question was a(n)omalous.
48. The panic was ge(n)eral.
49. He had lost everything except his ho(n)or.
50. The ship could be located by the smoke from her fu(nn)els.
51. The hedge needed pru(n)ing.
52. Such a contingency was extremely fortu(n)ate.
53. I could see that he was frow(n)ing.
54. The results were most ama(z)ing.
55. The water in the pipes was free(z)ing.
56. There was some question as to the re(s)ults.
57. One must act quickly and without he(s)itation.
58. She did not like ro(s)es.
59. He was unable to maintain his po(s)ition.
60. He left the game when he found that he was lo(s)ing.
61. He had left word that he would be extremely bu(s)y.
62. Are you acquainted with that ponderous tome which he is peru-(s)ing?
63. The yacht was intended for ra(c)ing.
64. The book was put a(s)ide.
65. The degenerate is marked by his a(s)ymmetry.
66. His time was spent in re(s)earch.
67. We made the preparation according to the re(c)ipe.
68. We were to travel through Europe on bi(c)ycles.
69. The empire included all Chri(st)endom.
70. He was a victim of hallu(c)inations.

71. We do not think that the combination is po(ss)ible.
72. The situation was highly amu(s)ing.
73. He was not aware of the storm he was arou(s)ing.
74. The problem of natural science is the interpretation of na(t)ure.
75. Contagious diseases are those which are called ca(tch)ing.
76. The reverend gentleman was a popular prea(ch)er.
77. On the wall hung a painting and two e(tch)ings.
78. For conquest he had a strange i(tch)ing.
79. We did not see the train approa(ch)ing.
80. The beef trust is hard on the bu(tch)er.
81. By his side the dog was crou(ch)ing.
82. Diseased tissues are studied by the pa(th)ologist.
83. War clouds are ga(th)ering.
84. He went into business with his fa(th)er.
85. Good speaking depends on good brea(th)ing.
86. The horses wait wi(th)out.
87. He had been shot through the head and lay on the ground wri(th)ing.
88. Many of the soldiers were without proper clo(th)ing.
89. It was not the difficulty that bo(th)ered.
90. The loss was next to no(th)ing.
91. The fire was almost smo(th)ered.
92. His death must be reported to the au(th)orities.
93. The illumination is ra(d)iant.
94. The pain was almost ma(dd)ening.
95. The statement is utterly incre(d)ible.
96. The train was backed upon a si(d)ing.
97. The men had left the car they were loa(d)ing.
98. The lawn needed so(dd)ing.
99. I saw the book which he stu(d)ied.
100. They did not know the trouble over which he was broo(d)ing.
101. He was evicted as an intru(d)er.
102. He was seen in Paris ten days la(t)er.
103. The governor refuses to discuss the ma(tt)er.
104. On his part the attitude was confessedly a pre(t)ense.
105. We counted on the rose five pe(t)als.
106. He is a good wri(t)er.
107. The leaders admitted that they could not meet the extremi(t)y.
108. We were to have gone boa(t)ing.
109. The tree is swaying and to(tt)ering.
110. The crowd was jeering and hoo(t)ing.
111. A man must earn his bread and bu(tt)er.
112. She was divinely beau(t)iful.
113. The project has been extensively exploi(t)ed.
114. The army was completely rou(t)ed.
115. The window was reset by a gla(z)ier.
116. The color of the sky was a(z)ure.
117. We do not get much lei(s)ure.
118. One does not live for plea(s)ure.
119. We waited within the enclo(s)ure.
120. The Poggendorf figure is an optical illu(si)on.
121. He did not welcome our intru(s)ion.
122. The matter interests the entire na(ti)on.
123. His pleading was fiery and pa(ssi)onate.
124. Several connoisseurs expressed their appre(c)iation.
125. We have already signed the peti(ti)on.
126. The life we lead is not real but facti(ti)ous.
127. Before us stretched the expanse of the o(ce)an.

128. The ballot is not free from pollu(ti)on.
129. The moment was cru(ci)al.
130. We were almost stunned by the concu(ssi)on.
131. Proceed along the path with cau(ti)on.
132. The most entrancing theories are the va(gu)est.
133. We had experienced the awful a(g)ony.
134. The king knew that his courtiers were intri(gu)ing.
135. He had killed lions and bears and ti(g)ers.
136. The army was made up of volunteers and re(g)ulars.
137. The lad had climbed into the ri(gg)ing.
138. The children were ro(gu)ish.
139. The ant tendered a reception to the slu(gg)ard.
140. The play was characterized by its unique sta(g)ing.
141. The affair is too horrible to ima(g)ine.
142. The criminal presented many marks of de(g)eneration.
143. The strips were used for e(dg)ing.
144. We found him most obli(g)ing.
145. He was not dogmatic in his reli(gi)on.
146. The term 'education' is preferred to 'pedago(g)y.'
147. We did not see him at his lo(dg)ing.
148. Industry without art is dru(dg)ery.
149. He was a notorious pu(g)ilist.
150. We bought bread of the ba(k)er.
151. The enterprise did not lack ba(ck)ers.
152. Death is followed by de(c)ay.
153. We are at the end of a de(c)ade.
154. Eric was one of the Vi(k)ings.
155. The fires are fed by an automatic sto(k)er.
156. There was plenty of food in the lo(ck)ers.
157. He got a good du(ck)ing.
158. I do not like him any lo(ng)er.
159. We heard that she was a good si(ng)er.
160. The evening chimes were ri(ng)ing.
161. The man was leaning over the rai(l)ing.
162. We had visited the pa(l)ace.
163. I did not know his fee(l)ing.
164. The missionary was most zea(l)ous.
165. It is called latter-day Phi(l)istinism.
166. All sciences have grown out of phi(l)osophy.
167. The people are not civi(l)ized.
168. We took our exercise by bow(l)ing.
169. The coat had a velvet co(ll)ar.
170. He chided him for his foo(l)ishness.
171. The procedure was acknowledged to be irregu(l)ar.
172. He is blind to certain co(l)ors.
173. The disaster is appa(ll)ing.
174. The water is improved by boi(l)ing.
175. The wind was how(l)ing.
176. The law is subject to many va(r)iations.
177. I have not a word against his private cha(r)acter.
178. We were among her admi(r)ers.
179. The procedure was most i(rr)egular.
180. Do not always look for the mo(r)al.
181. They came away much poo(r)er.
182. His hesitancy is natu(r)al.
183. Mrs. Smith was to do the pou(r)ing.

Theoretically, the sentences numbered in all 1085, but owing to the difficulty encountered in finding words for all classes, as

well to imperfections in the records, only 850 sentences were used.

The words and sentences were recorded upon the cylinders of an Edison phonograph[1] (Class M). Care was taken to speak the words distinctly, but in general the emphasis and inflection were those of ordinary conversation. All the words and sentences were recorded by one person (the author). The time of the revolution of the cylinder was constant both in making the records and in making experimental tests (160 revolutions per minute, verified at the beginning of each experimental hour).

The mutilated words were first placed alone upon one set of cylinders, words of the different classes,—A, B and C—being recorded together to eliminate possible errors of expectation. The observers were instructed to listen to the word as reproduced by the phonograph, and to repeat it to the operator, who recorded the judgment. Occasional unmutilated words were inserted as checks.

The sentences were recorded upon a second set of cylinders, care being taken to mix the various classes as in the case of words. The observer was instructed to listen to the sentence as reproduced, and to repeat it to the operator, who recorded it as given by the observer, noting at the same time the errors made in the perception of the separate words.

For one series of the single mutilated words, the procedure was as follows: Two seconds before the word was reproduced by the phonograph, the operator spoke two words which stood in the relation of context to the mutilated word. The observer's reactions upon the word, both with context and without context, were recorded.

It will be noted that this method is practically that which Pillsbury[2] used in his experiments upon the reading of words, with the exception that our own method is complicated by the use of the sentence as context. Indeed, the aim of this part of our problem was, primarily, to do for the spoken word what Pillsbury had done for the printed word.

The experiments extended through two academic years (1898–99, 1899–1900), tests being made only during the morning hours.

§ 2. *Observers.* For the first two experiments on the perception of auditory symbols, the following eight members of the Department of Psychology, Cornell University, volunteered to act as observers: Dr. J. O. Quantz, Dr. G. A. Cogs-

[1] A discussion of the applications of the phonograph to psychological work will be found in *Les Phonographes et l'Étude des Voyelles*, by Dr. Marage, in *L'Anné Psychologique*, 1898, pp. 226 ff.

[2] Pillsbury: *op. cit.*, p. 341.

well, Dr. G. M. Whipple, Dr. W. B. Lane, Miss F. M. Winger, Miss J. A. Cochran, Mr. H. O. Cook, and Mr. R. M. Ogden. While the nature of the experiment necessitated a certain amount of knowledge on the part of the observers regarding the work in hand, the special object of the tests was unfamiliar to them, and the general procedure may be designated as 'without knowledge.'

It will be readily seen that the use of every possible combination as given above (p. 88) would introduce into the experiment a source of error which must, as far as possible, be avoided. The words were first given alone, and then repeated once or twice with a contextual connection. By permitting a relatively long interval of time—two to four months—to elapse between each repetition of the word in the various connections, the recognition of the word as having occurred in a previous test happened very infrequently. Had every combination been used for each word, such a procedure would have been quite impossible.

§ 3. *Results and Conclusions.*

PROBLEM I. THE INFLUENCE OF CONTEXT UPON THE PERCEPTION OF AUDITORY SYMBOLS.

In this connection we have to compare the results of giving mutilated words alone, of giving them with a minimum of context, of giving them at the beginning of complete sentences, of giving them in the middle of such sentences, and of giving them at the end of such sentences.

(a) *Words Given Without Context.*

Table I shows the percentage of mutilated words correctly perceived when given without context. The letters A, B and C refer to the place in the word at which the elision was made —A, initial consonant elided; B, mid-consonant elided; C, final consonant elided.

TABLE I.

Class.	Total No. Judgments.	Right.	Wrong.	Perc't R't.
A	260	9	251	3.5
B	450	189	261	42.0
C	260	34	226	13.0
Totals,	970	232	738	23.9

The relatively high number of right judgments in the B-series is probably due, in large measure, to the fact that where the mid-consonants are omitted the words are predominantly polysyllabic. The A and C series were entirely monosyllabic. With this difference, the B-series should, of course, be left out of any comparison. The following conclusion seems to follow from the Table:

1. *In monosyllabic words the elision of the initial consonant affects perception more than the elision of the final consonant.*

This conclusion is in substantial agreement with Pillsbury's results for printed words: "A disfigurement of the first letter was easily recognized, since there was but slight expectation of what was to come."[1] The fact also suggests Goldscheider and Mueller's conclusion that the initial letters are among the predominantly 'determining' elements in reading,[2] as well as Huey's conclusion regarding the importance of the first part of the word in perception.[3] The fundamental rôle which the initial consonants play in the genesis of speech is illustrated by the fact that the first consonants which the child uses are initial, and that only initial consonants are used for some time.[4]

(b) *Words Given with a Minimum of Context.*

The words used in this determination were chosen from the B-series. A complete record of one observer is given below.

		Observers' Report.	
Mutilated Word.	Context.	Word Alone.	With Context.
A			
A(m)iable	friend, cherished	a(m)iable	amiable
Sla(mm)ing	doors, childhood	slatting	slammed
E(m)otional	elements, determine	e(m)otional	e(m)otional
Gli(mm)ering	guided, light	query	twinkling
Ele(m)ents	water, hydrogen	eloquence, elegant	ele(m)ents
Rhy(m)ing	adolescence, instinct	riding	rising
Mo(m)ent	caught, flies	owen	woman
No(m)ination	his, assured	darnation	nomination
Loo(m)ing	up, Mt. Washington	bluing	loo(m)ing
Calu(mn)y	him, heaped	calumny	calumny
Wo(m)an	bundle, foibles	one	one
Bra(v)est	men, fear	brayers	brave
Ca(v)il	calumny, unscathed	hal	cavil
Achie(ve)ment	little, criticism	achie(v)ement	achievement
Re(v)elation	universe, interpreted	revelation	revelation
Di(v)ersity	interest, friendship	diversity	diversity
Di(v)ine	interference, human	decline	divine
O(v)er	divide, land	or	war

[1] Pillsbury: *op. cit.*, p. 350.
[2] Goldscheider and Mueller: *op. cit.*, p. 160.
[3] Huey: This *Journal*. Vol. IX, p. 581.
[4] Tracy: The Psychology of Childhood, p. 127.

		Observers' Report.	
Mutilated Word.	Context.	Word Alone.	With Context.
No(v)el	force, life	now	{doll, shall}
Pro(v)ing	error, process	{cooing, cooling}	accruing
Lo(v)able	women, courtesy	{gavel, garbel}	lovable
Lau(gh)ing	leads, obesity	thine	laughing
Be(f)ore	honor, effort	the oar	before
Dea(f)ening	roar, disaster	dea(f)ening	deafening
Li(fe)like	picture, praise	{lie-like, li(fe)like}	lifelike
O(ft)entimes	wander, alone	{on time, autumn-time}	{olden times, on time}
Stu(ff)ing	{animals, taxidermy}	starting	stuffing
Ba(b)ies	{bachelor's, bugbears}	baize	bays
Voca(b)ulary	important, book	voca(b)ulary	voca(b)ulary
Descri(b)ing	{personal, adventures}	descrying	describing
Scri(bb)ling	verse, genius	shrilly	squirling
No(b)ler	men, better	nola	older
Ro(bb)ing	genteel, vocation	drawing	calling
Ru(b)ies	{diamonds, precious}	Ruiz	Ruiz
Scru(bb)ing	floor, artistic	scrawling	scru(bb)ing
Ca(p)able	better, things	ca-able	capable
Ra(p)acious	{politicians, monopolized}	veracious	veracious
Re(p)entance	{itself, constructive}	{prentice, pre-empted}	the entrance
She(ph)erds	flocks, night	charades	charade
Gri(pp)ing	man, throat	spearing	grinning
Slo(p)ing	walls, ascent	flowing	flowing
Dro(pp)ing	wall, escape	drawing	drawing
Stu(p)endous	gorge, wonder	stu(p)endous	stu(p)endous
Cu(p)id	life, part	Hewet	stupid
A(n)omalous	{position, comment}	anomalous	anomalous
Ge(n)eral	disaster, panic	Jerrold	Jerrold
A(n)yone	done, better	a-one	A-1
Pho(n)ographs	products, decade	phonographs	phonographs
Ho(n)or	before, effort	all	awe
Croo(n)ing	scandalous, tales	accruing	accruing
Combi(n)ations	{capital, dangerous}	combinations	combinations
Su(pp)osing	true, result	supposing	supposing
Fortu(n)ately	well, armed	fortunately	fortunately
Fu(nn)els	clouds, smoke	false	funnels
Cra(z)y	stories, believed	cra(z)y	crazy
Re(s)ults	{whatever, interesting}	real	real
He(s)itation	critical, failure	citation	hesitation
Civi(l)ized	nations, war	civilized	civilized
Ro(s)es	violets, grown	rose	rose
U(s)ing	gun, club	hewing	hewing

In all, 358 judgments were recorded; 183 with context and 175 without context. Table II shows the percentage of correct perception for both classes.

TABLE II.

	Without Context.	With Context.
Total Judgments,	175	183
Right Judgments,	50	96
Wrong Judgments,	125	87
Per cent. Right,	28.5	52.4

Lest the 28.5% of this last determination may be thought inconsistent with the 42.0% of Table I, it will be well to explain that the words chosen for the test represent only those members of the B-series which were the most difficult to perceive after mutilation. The following conclusions seem warranted:

2. *When mutilated words are given with a minimum of context, the chances for their correct perception are increased by 82% as compared with their chances of correct perception when given without context.*

3. *The fact of mutilation is readily noticed in the single words given without context, even though the word be finally correctly perceived; the elision is not so readily noted when the word is given with a minimum of context.*

These conclusions are again in full agreement with Pillsbury's results for the visual word.[1]

(c) *Words given at or near the Beginning of Complete Sentences.*

Two of the sentence series—A and B—furnished the data for this determination. Tables III and IV give the results.

TABLE III. SERIES AA.

	Given Alone.	At the Begining of Sentence.
Total Judgments,	260	390
Right Cases,	9	288
Wrong Cases,	251	102
Per cent. Right,	3.5	73.8

Here the A-words have leaped, by the influence of context, from 3.5% of correct perceptions, when given alone, to 73.8% of correct perceptions, when placed at the beginning of a complete sentence. The B-words have increased much less rapidly, as the following Table shows.

[1] Pillsbury: *op. cit.*, p. 361.

TABLE IV. BA SERIES.

	Given Alone.	At the Beginning of Sentence.
Total Judgments,	450	944
Right Judgments,	189	557
Wrong Judgments,	261	387
Per cent. Right,	42	59

The following conclusions are to be drawn:

4. *Polysyllabic words when mutilated are more easily recognized than monosyllabic words under the same conditions, but, when given in context, are not helped by the context as much as are the monosyllabic words.*

5. *When mutilated words are placed at or near the beginning of complete sentences, the chances for their correct perception are increased remarkably, the amount of increase varying with the character of the word, being greater for monosyllables and less for polysyllables.*

(d) *Words placed in the Middle of Sentences.*

Only one of the sentence-series—Cb—was used in this determination. The C-words were all monosyllables; hence, the results of this determination are comparable with the Aa series of Determination 'c.' Table V gives the results.

TABLE V. THE CB SERIES.

	Word Given Alone.	Given in Middle of Sentence.
Total Judgments,	260	498
Right Judgments,	34	399
Wrong Judgments,	226	99
Per cent. Right,	13.0	80.1

Here we find a distinct gain in correct perception over the last determination. In comparing this series with series Aa of Determination 'c,' the objection may be raised that the C series has already been proven more easily perceived than the A series, and that, therefore, the gain from 73.8% (the result of the Aa series of Determination 'c') loses its significance. When, however, we take into account the long leap that both series make when given the advantage of context, this difficulty does not appear so great as at first sight. The following conclusions seem to be justified:

6. *When mutilated words are placed in the middle of complete sentences, there is a slight but significant increase in the percentage of correct perceptions as compared with the perceptions of the similar words placed at the beginning of complete sentences.*

7. *When mutilated words are placed in the middle of complete sentences, they are much more amenable to correct interpretation than when given without context.*

(e) *Words given at the End of Complete Sentences.*

Series Ac, Bc, and Cc are represented in this determination. The results are shown in Tables VI, VII and VIII.

TABLE VI. THE AC SERIES.

	Given Alone.	Beginning of Sentence.	End of Sentence.
Total Judgments,	260	390	114
Right Judgments,	9	288	100
Wrong Judgments,	251	102	14
Per cent. Right,	3.5	73.8	87.7

TABLE VII. THE BC SERIES.

	Given Alone.	Beginning of Sentence.	End of Sentence.
Total Judgments,	450	944	507
Right Judgments,	189	556	408
Wrong Judgments,	261	387	99
Per cent. Right,	42	59	80.4

TABLE VIII. THE CC SERIES.

	Given Alone.	Middle of Sentence.	End of Sentence.
Total Judgments,	260	498	404
Right Judgments,	34	399	366
Wrong Judgments,	226	99	38
Per cent. Right,	13.0	80.1	90.5

The conclusion follows:

8. *The position most favorable for the correct perception of a mutilated word is at the close of a complete sentence.*

Table VII shows the general relations of all the classes.

TABLE VIII. GENERAL RELATIONS.

Min. Con.=Minimum Context. T=Total Judgments. R=Right Judgments.

Class.	Alone.		Min. Con.		'a'		'b'		'c'	
	T	R	T	R	T	R	T	R	T	R
A	260	9			390	288			114	100
B	450	189	183	96	944	556			507	408
C	260	34					498	399	404	366
	970	232	183	96	1334	844	498	399	1025	874
P. c'nt. R't,	23.9		52.4		63.2		80.1		85.2	

9. *The temporal position of a mutilated word in the succession of contextual elements with which it is given, determines the amount of injury which the word as an unit of auditory perception sustains through mutilation.*

PROBLEM II. THE RELATIONS OF THE SYMBOLIC ELEMENTS TO ONE ANOTHER IN AUDITORY PERCEPTION.

Have the various consonants, or classes of consonants, varying degrees of significance for perception? Are there among the auditory symbol elements certain elements which are 'determining' and certain others which are 'indifferent,' as Goldscheider and Mueller maintain to be the case in visual symbol elements? We have already found that the *position* of an element is a determining factor in perception. This, however, can be interpreted as analogous to the influence of context; for since the initial element possesses the greatest significance for perception, it is reasonable to suppose that the mid and final elements lose significance through the associative supplementing of the preceding elements. The question now arises: apart from this associative supplementing, are there other objective or physiological factors which give the various elements a varying degree of significance? Are certain consonants, either because of the ease with which they are produced or by reason of their peculiar quality, more fundamental than other consonants?

The word-series B was used in this experiment, the general object being to determine what consonants could be elided with the least injury to the perception of the word. Table IX gives the results. The percentages represent all the judgments made upon the mutilated words, whether with or without context, the assumption being that the context helped all classes of consonants impartially.

TABLE IX.

Injury Worked to Perception of Mutilated Word by Elision of Different Kinds of Consonants.

CONSONANT ELIDED.	TOTAL JUDGMENTS.	RIGHT.	WRONG.	
Mutes.				
p	47	20	27	
b	28	9	19	
d	44	25	19	
t	43	22	21	
g	26	12	14	
k	40	14	26	
Totals,	228	102	126	44.7% Right.
Spirants.				
f	23	9	14	
v	38	18	20	
th	27	11	16	
j	43	25	18	
ch	29	13	16	
Totals,	160	76	84	47.5% Right.

Sibilants.				
s	36	20	16	
z	16	3	13	
sh	42	21	21	
zh	18	11	7	
Totals,	112	55	57	49.1% Right.
Nasals.				
m	43	17	26	
n	32	23	9	
ng	9	2	7	
Totals,	84	42	42	50.0% Right.
Semi-vowels.				
w	10	7	3	
r	36	28	8	
l	42	28	14	
Totals,	88	63	25	71.6% Right.

10. *The elision of mutes works the greatest injury to the perception of a mutilated word; the elision of the semi-vowels works the least injury to such perception. Elision of spirants, sibilants and nasals works greater injury than the elision of semi-vowels, and less injury than the elision of mutes.*

We have in this instance a striking correlation with the facts of language development. In the phylogeny[1] and ontogeny[2] of speech the mutes are the first consonants to appear. They are also the easiest to form, involving the least complex musculature and the slightest delicacy of co-ordination.

11. *The consonants which are of the greatest significance in the auditory perception of words are those which involve in their production only the coarser articulatory combinations. They may, therefore, be considered as the more fundamental elements of auditory symbolism.*

These results may now be compared with the substitutions which the various observers made when the words were misperceived. The data of this determination are mostly such words as were *not* filled out by the observer into 'meaningful' but into nonsense symbol-complexes. Hence the substitutions made may well be considered as, in the main, those which followed the 'line of least resistance;' those, in other words, which required the least expenditure of energy for their production. Some examples are given below:

Word Given.	Word Reported.
sla(mm)ing	slatting
no(m)ination	notination

[1] *Cf.* Whitney: Life and Growth of Language, p. 68.
[2] *Cf.* Tracy: Psychology of Childhood, p. 127.

Word Given.	Word Reported.
fe(tch)ing	fetting
ga(th)ering	ackering
na(ti)on's	valiance
a(g)ony	arry
pu(g)ilist	purellas
du(ck)ing	dunning
mo(m)ent	oak cent
ca(v)il	cattle

TABLE X.

The Comparison of Multiple and Single Elements Appearing in the Substitutions.

	No. of Elements Represented.	No. of Substitutions.	Average for each Element
Single Elements,	22	221	10.
Multiple "	14	21	1.5

By 'multiple elements' are meant combinations of single consonants or digraphs.

12. *Multiple elements are substituted much less frequently than single elements; in the proportion of 15 to 95, or, approximately, 1:6.*

TABLE XI.

The Comparison of Different Classes of Single Elements Appearing in the Substitutions.

Total Number of Substitutions.....221

Mutes.		Spirants.		Sibilants.		Nasals.		Semi-vowels.	
p	3	f	1	s	6	m	2	v	63
b	6	v	7	z	1	n	2	r	26
d	11	th	5	sh	4	ng	8	l	21
t.	26	j	3	zh	0			y	15
g	1	ch	2						
k	8								
Total,	55		18		11		12		125
Av. for each	Mute, 9.1	Spiran ,	3.6	Sibilants,	2.7	Nasals,	4	Semi-v'ls,	31.2

The preponderance of semi-vowels substituted may seem remarkable in the light of the last determination, where we pointed out that the mutes are not only the 'easiest' elements to produce vocally, but also the most fundamental in the genesis of speech, while the semi-vowels are the hardest to acquire and the latest to develop, both phylogenetically and ontogenetically. But while they are the latest to develop, they are not, once mastered, the most difficult to use, but rather are among the easiest. In the practiced use of language, "each class (vowels and consonants) draws the other toward itself; the vowels become more consonantal, the consonants become more vocalic."[1] Hence, it might well be expected that the semi-vowels, standing as they do on the border line

[1] Whitney: Life and Growth of Language, p. 69.

between the voiced and the unvoiced elements, should appear most frequently in the substitutions of adult speakers. In view of this fact, the following conclusion seems to be justified:

13. *When different single elements are substituted for the elided elements in mutilated words, the semi-vowels are chosen most frequently, the proportion being approximately three semi-vowels to two substitutions from all other classes. When semi-vowels are not substituted, the mutes are chosen more frequently than either the sibilants or the nasals, in the proportion approximately of three mutes to one substitution from any one of the other classes except semi-vowels.*

B. The Conscious Process Involved in the Apperception of Spoken Symbols.

§ 1. *Object.*

From the series of mutilated words that were given, now singly, now with a minimum of context, now at the beginning, now in the middle, and now at the end of a complete sentence, it is evident that the 'setting' of a word is the determining factor in its apperception. The problem that confronts us, therefore, is this: Given a complex of sounds, otherwise perceived simply as such a complex, what are the conscious processes by which this complex acquires 'meaning;' by which it is not merely perceived as sound, but apperceived as a 'meaningful' symbol?

Apperception is used in this connection to denote the reaction of experience upon new contents, or, as Pillsbury puts it, "apperception represents the influence of general experience in consciousness."[1]

This connotation of the term apperception, now generally adopted, was vaguely suggested by Leibniz;[2] but it was the Herbartians who first gave it an important significance in psychological nomenclature. According to Herbart,[3] a new idea is apperceived by an older idea or by a complex of older ideas. With Drobisch,[4] the apperceiving idea becomes a distinct 'psychological subject.' There is a psychological subject corresponding to every characteristic attitude of the mind. Now we are teachers, now students, now members of a political community. In every case a special psychological subject presides over the mental life, and the nature and constitution of this subject determine the form in which the newly entering contents shall be received. Waitz[5] introduces the doctrine of apperception by 'coenæsthesis.'

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[1] Pillsbury: *op. cit.*, p. 388.

[2] Leibniz: Philosophical Works (Tr. Duncan). New Haven, 1890, pp. 219.

[3] Herbart, J. F.: Psychologie als Wissenschaft. Sämmtliche Werke (Kehrbach's ed.), Langensalza, 1892. Bd. VI, pp. 140 ff.

[4] Drobisch, M.: Empirische Psychologie nach wissenschaftlicher Methode. Leipzig, 1842, p. 135.

[5] Waitz, T.: Grundlegung der Psychologie. See also Stout, *Mind*, Vol. XIV (1889), p. 366.

Coenæsthesis is the mental attitude, the 'common feeling,' which is produced by every form of stimulus. In other words, coenæsthesis is the resultant of experience. With Lazarus,[1] an apperception is joined to a perception in the act of assimilation. The apperception is thus conceived as a structural pattern of the mind. It is, however, an active agent, and its efficiency is due to the working-over which it has undergone throughout the course of experience. Steinthal[2] means by apperception all the psychical factors and activities which mediate a cognition. It is the movement of two ideas governed by the *Weltanschauung* of the subject,—the movement of two ideas for the production of a cognition. Stout[3] includes under apperception such processes as understanding, interpreting, identifying, subsuming, etc. In all these processes, a presentation "acquires a certain significance for thought by connecting itself with some mental preformation as this has been organized in the course of previous experience." The process of apperception coincides substantially with that of attention. In the Herbartians, both the agents and the materials of apperception are ideas or idea complexes; in Stout, the materials of apperception are involved in the concept of mental 'systems.' A mental group or system is a systematized tendency, and the union of such groups or systems is the confluence of different modes of mental activity. (*Cf.* the 'psychological subject' of Drobisch.) Regarding the agent of apperception, Stout renounces the Herbartian concept of ideational activity, and considers apperception as a conative process. With Wundt,[4] apperception is the process through which one idea becomes clear and distinct, while others remain vague and indefinite, the entire process being accompanied by a feeling of activity, by the inhibition of irrelevant ideas, and by other accessory phenomena.

The problems in a study of apperception are revealed more clearly if the dichotomy between a structural and a functional psychology, as proposed by Professor Titchener,[5] is rigidly made and adhered to. Apperception is a *function* of the mind. It has its *structural* pattern, *i. e.*, there is a certain mental state or condition which the apperceiving consciousness uniformly takes, and this state or condition is called attention.[6] In a study of apperception, then, we have to inquire, what structural elements or compounds of elements carry the function of apperception. In what proportions are sensational and affective elements present, under different conditions, in the apperceptive consciousness? The mind assimilates the new material which is presented to it in a form determined by the environment.

[1] Lazarus, M.: Das Leben der Seele. Berlin, 1878, pp. 251 ff.

[2] Steinthal, H.: Einleitung in die Psychologie, etc. Berlin, 1881, pp. 166-263.

[3] Stout, G. F.: Analytic Psychology. London, 1806. Vol. II, pp. 110 ff.

[4] Wundt, W.: Grundzüge der physiologischen Psychologie. Leipzig, 1893. Bd. II, pp. 274 ff.

[5] Titchener, E. B.: An Outline of Psychology. New York, 1899, pp. 21 ff. The Postulates of a Structural Psychology, *Philosophical Review*, Vol. VII, 5. (Sept., 1898.)

[6] *Cf.* Kuelpe, O.: Outlines of Psychology (Tr. Titchener). London, 1895, pp. 423 ff.

What are the conscious processes which, on the structural side, constitute this assimilation? What is it that determines the particular pattern of the given apperceptive consciousness? Why are such and such perceptions and ideas in the focus, and such and such perceptions and ideas in the fringe of consciousness? What is the nature, under the given conditions, of the elements which fall in the focus, and what is the nature, under the same conditions, of the elements which fall in the fringe? Is there any uniformity with which these several arrangements of mental 'stuff' occur? If there is, does it suggest, directly or indirectly, a general postulate upon which a psychology of function can build?

Viewing our own problem—the apperception of spoken symbols—from this standpoint, we have to ask: What is the character of the associative and recognitory processes that underlie the apperception of symbols? In terms of what sense-modalities are our symbols interpreted? What part do mood, affective tone, environment, past experience, and similar factors play in the interpretation?

§ 2. *Method.*

The method employed in this determination was that of introspective analysis. The sentences were the same as those used in the first two determinations; a sample series has been given above (p. 88). The procedure was, in brief, as follows. After the sentences had been reproduced by the phonograph and repeated by the observer, the latter was instructed: (1) to give an introspective account of the manner in which he came to fill out the mutilated word, providing that the mutilation was recognized; and (2) to add all possible information as to the character of the mental processes which went on during the apperception of the sentence, with especial regard to the pattern of the apperceptive consciousness,—the presence or absence of definite and tangible 'imagery,' the concomitant affective phenomena, kinaesthetic sensations, etc. The results of the experiment fall into two sections, corresponding to these two divisions of the problem.

§ 3. *Observers.*

The value of the introspective reports must depend in large measure upon the training and ability of the various observers. Of the four observers whose protocols embody such reports, three were professional psychologists of from four to six years' technical training and experience. The fourth was a student of two years' training in psychological method. All were very much alive to the value of accurate introspection, and could differentiate clearly between the psychological and the logical implications of the matter with which they dealt.

The following observers offered their services for this deter-

mination: Miss F. M. Winger (*W*), Fellow in Psychology; Miss J. A. Cochran (*C*), senior student in psychology; Dr. G. M. Whipple (*Wh*), Assistant in Psychology; and Dr. W. B. Lane (*L*), Honorary Fellow in Psychology,—all of Cornell University. *W* and *L* are predominantly visual in type; *C* is predominantly auditory; and *Wh* auditory-visual.

The experimental work began in October, 1899, and continued until June, 1900. The experimental hours were ten, eleven and twelve in the morning. No tests were taken in the afternoons. *Wh* gave one hour a week to the work, *L* and *C* two hours a week, and *W* three hours a week.

§ 4. *Results.*

(a) *The Interpretation of Mutilated Symbols: The Principle of Contextual Supplementing.*

We have seen that, when a mutilated word is given alone, the chances are that its meaning will be lost upon the hearer; but when it is given in context, the chances are that the elisions will be filled out and the word supplied in its correct form. When a word is spoken erroneously, but is correctly perceived by the hearer, the process by which the errors are filled out has been described as 'associative supplementing.'[1] It is obvious that this involves a certain form of apperception. The erroneous part of the spoken word is filled out immediately from the hearer's experience, and this is always an instance of simultaneous association. But when the word is recognized as mutilated, the correct form is provided in large part by the context, and is only at first suggested and later confirmed by the mutilated form. This process may be called 'contextual supplementing,' and is an instance, not of simultaneous, but of successive association.[2] The greater part of the elisions in our sentences were supplied in this way.

14. *The mutilated word given in context is not, as a rule, filled out at once by associative supplementing, but is changed into its correct form by a process of successive association which, inasmuch as it is dependent almost entirely upon the context, may be called contextual supplementing.*

Illustrations: "He sold his ho(me) for a mess of pottage." *Wh* first misinterpreted *ho(me)* as *hole*. He then "tried to think what Esau sold;" *birthright* came up by successive association, then *home* was readily supplied.

"The matter is a function of ti(me) and space." *L* misinterpreted *ti(me)* as *tide*, but the juxtaposition of *space* led to the substitution of *time*.

"Is it the man or the no(se) in Cyrano?" *C* supplied *nose* after *Cyrano* had been spelled for her.

[1] Titchener: *op. cit.*, pp. 216 ff. See also Bawden, A Study of Lapses. pp. 41-44.

[2] Titchener: *op. cit.*, p. 216.

"Na(t)ure abhors a vacuum." *L* would not have supplied the *ch* sound in nature had he not heard *abhors*, which immediately suggested it.

"Ga(th)ering news was his trade." *C* perceived *ga(th)ering* as the nonsense word *ackering*. Very much later she supplied *gathering*, but was unable to analyze the process by which she had reached it.

"Wri(th)ing in pain, he called for help." *C* supplied *writhing* after apperceiving *pain*.

"Wi(th)out health, happiness is perhaps impossible." *Wh* misinterpreted *health* as *help*. He changed it to *health* upon the completion of the sentence.

"The ra(d)iant diamond is but a bit of carbon." *Wh* could make nothing out of *ra(d)iant*, but supplied *radiant* "simply because it was appropriate."

"Gree(d)ily he seized and ate the food." *C*, *W* and *Wh* misinterpreted *gree(d)ily* as *really*. *C* supplied *greedily* from the word *seized*, *Wh* and *W* from the general context.

"Incre(d)ible as the story may seem, it is true." *Wh* first took *incre(d)ible* as *in travel*. He substituted the correct form after *seem* or *true*.

"Ma(tt)er and force are in the province of the knowable." *Wh* filled out *matter* from the suggestion of *force* and *knowable*.

"Wri(t)ers of novels are legion in these days." *C* did not supply *writers* until she had apperceived *novels*.

"The a(z)ure of the sky was changed to gray." *Wh* supplied *azure* from *sky; C* substituted *azure* after *gray*.

"The cau(ti)on was timely." *Wh* misinterpreted *caution* as *column*. When asked for further associations, he said: "I noticed no mutilations. The sentence suggested the stereotyped phrase: 'The caution was timely.'"

"The slu(gg)ard should eat the fruits of his sloth." *L* first reported, "The Sclav should eat the fruits of his Sclav." This had a 'familiar feel' and suggested a scriptural text. *Sloth* was suggested by the experimenter as the last word, and *L* at once supplied *sluggard*.

"Golf is an interesting ga(me)." *Golf* was misinterpreted by *L* as *gold*. *Golf* was substituted by the context, and confirmed by the sound.

"The siege was interrupted by a tru(ce)." *C* misinterpreted *tru(ce)* as *true*, but supplied *truce* after *siege*.

"The ruling of the court was null and voi(d)." *Wh* supplied the word *void* immediately from the familiarity of the phrase. (This was doubtless a case of simultaneous association.)

It will be noted that most of these contextual supplementings can be grouped under three of Aschaffenburg's[1] rubrics of successive associations. These comprise the first two classes of his 'internal' associations, (*Associationen nach Co-ordination* and *Associationen nach prädicativer Beziehung*) and one class of his 'external' associations (*sprachliche Reminiscenzen*). Probably the majority are of the last-named type.

(b) *The More General Factors in Sentence Apperception.*

In this determination the lack of an adequate method or

[1] Aschaffenburg, G.: Experimentelle Studien ueber Associationen. Kraepelin's *Psychologische Arbeiten*, Bd. I, H. 2 and 3 (1895), p. 231.

schema of classification rendered the task more difficult. We had nearly three thousand introspective reports in protocol upon the conscious processes involved in interpretation. Each of these reports was extremely individual in character, and just what value to ascribe to each was a matter of serious import. The plan finally adopted was as follows. The writer went through the protocols rapidly, noted the character of each introspection, and made a rough classification of the material, working from the points that seemed to him most salient. Then the protocols were more carefully examined, and each introspective unit was assigned to its proper class. In this way numerical comparisons of the various types of imagery employed, of the sensational and affective phenomena, and of subjective and objective references were made possible. At the same time the more typical and the more striking reports were recorded separately, and from these a few have been selected for citation. The following is the classification as it took final form.

TABLE XII.

References involving visual sense-elements:		
Ideal reproduction of a represented environment,	199	instances.
Visual imagery of particular objects reinforcing a general reference,	217	"
Visual reference to maps,	15	"
Visual reference to pictures,	35	"
Visual reference to books,	15	"
Visual reference to persons,	155	"
Total visual references,	636	"
References involving auditory sense-elements,	30	"
References involving kinaesthetic sense-elements,	26	"
References involving taste and smell elements,	4	"
References involving temperature sense-elements,	30	"
Verbal references:		
Purely verbal references,	218	"
Verbal completions and supplements,	61	"
References to literature, history, etc., predominantly verbal,	38	"
References involving schematic representations, largely verbal,	14	"
Particular words visualized, innervated or heard,	62	"
Verbal references to previous sentence,	13	"
Verbal references to contexts,	23	"
Peculiar lines of thought initiated, largely verbal,	13	"
Total verbal references,	532	"
References uniform with the various observers,	132	"
Constant supplements,	38	"
Indefinite, changing and obscure references:		
References showing a hesitation between alternatives,	16	"
Different references at different parts of the context,	2	"

References which change gradually as the context proceeds,	40	instances.
References which take a figurative meaning in its literal sense,	5	"
Contexts erroneously perceived and curiously interpreted,	96	"
References inconsistent with the context,	9	"
Total indefinite, changing and obscure references,	168	
References indistinct or absent:		
Reference vague and unorganized,	48	"
Only the auditory experience of the sentence in consciousness,	16	"
Familiarity with the sentence precludes definite and distinct reference,	6	"
Peculiarity in the mechanism of the sentence makes the reference indistinct,	5	"
Indistinct reference coming very late,	9	"
Total indistinct or absent references,	84	"

15. *Under the conditions of our experiment, and with the observers tested, the apperception of auditory symbols involves the presence in consciousness of visual and verbal ideas mainly; i. e., the conscious 'stuff' of the auditory symbolic apperception is made up in large part of visual and verbal (visual-auditory-kinaesthetic) sense elements. The auditory and kinaesthetic elements (apart from the rôle which they play in the formation of the verbal idea)*[1] *seemingly form but a small part, and the temperature, taste, and smell elements a still smaller part, of this 'stuff.'*

16. *The most complete form which the visual sense elements take is that of an ideal reproduction, more or less faithful, of a typical environment as represented by the context. Such a reproduction is common only with visually-minded observers and under optimal conditions of attention. It is usually complicated with other sensible and affective elements, but in such cases the visual elements predominate and occupy the focus of attention.*

Illustrations: "Not a man ha[s][2] had his vote refused him." *L* visualized a voting card and a polling station. The vote was upon the 'license' question. The consciousness of this last reference took the form of the word 'temperance' printed with a capital T. There was some excitement about the city which, in the ideal reproduction, took the form of noise memories. *Wh*, on hearing the same sentence, visualized the interior of the town hall of his native city, where voting was going on.

"The dogs were held in lea[sh]." *L* pictured a hunt, with a number of horses, dogs, etc., in the foreground.

"The principal plants indigenous to America are the potato, tobacco

[1] *Cf.* Titchener: *op cit.*, p. 208; Bawden: *op cit.*, pp. 59-60; Raymond Dodge: Die motorischen Wortvorstellungen, pp. 2-3.

[2] A letter enclosed in brackets [ ] or parentheses ( ) is the elided letter of the sentence. Where the brackets are used the elision did not involve the misinterpretation of the word.

and mai[ze]." *W* visualized maize and potatoes growing and tobacco manufactured.

"The ship could be traced by the smoke from her fu(nn)els." *W* misinterpreted *fu(nn)els* as *bows*. She reported the following situation: "The ship was on fire. I was on another ship at first, and could see the smoke coming over the horizon. Then I was on the burning ship watching the smoke coming from the bows."

"The safe door closed with a sna[p], and the cashier was a helpless prisoner." With this sentence *Wh* had a "vague visualization of a man standing in the middle of a bank office. The safe door was back of him. He was a tall man with a smooth face and a derby hat. He had a valise in his hand and appeared to be startled at something. He was the cashier." In this case, as in many others which we shall cite later, the reference was not in every way consistent with the context. *Wh* remarked upon this inconsistency in the protocol.

"A balmy bree[ze] wafted us to the south." *C*'s reference was not immediate, but followed some seconds after she had repeated the sentence. She visualized a river between two banks. "The river seemed very long."

"Gree[d]ily he seized and ate the food." *Wh* visualized a man eating with both hands.

"By goa[d]ing the oxen constantly, he managed to move slowly on." After the sentence had been repeated, *Wh* referred it to a country road near Topsfield, Mass. He visualized a yoke of oxen and a driver. *W*, with the same sentence, visualized an ox-cart and a man walking beside the oxen.

"The peti(ti)on received some attention." *L* misinterpreted *peti-(ti)on* as *Acteon*, which he took to be a Greek name. The sentence referred to a man's reception—a public reception to a famous man—which *L* visualized, together with a Greek audience which was applauding.

"He sleeps in a nameless gra[ve]." *Wh* visualized a soldier's grave on the side of a hill against a background of pines.

"The seed was covered with a white fu(zz)." *L* interpreted this sentence as, "The seed was covered with a white fog." He later supplied *sea* for *seed*, and with this he visualized the sea enveloped in fog and a steamer moving through it. The ideas *slow-speed* and *fog-signal* (modalities uncertain) were also present.

"The sermon was unconscionably lo[ng]." *W* visualized a "lot of people sitting and waiting for the end to come. It was very quiet." She did not see the preacher.

"Ships were frequently wrecked upon the ree[f]." *L* visualized the open sea off the Manacles, and in it a ship partially submerged. This was supplemented by the verbal associate 'Paris.'

"Schools of fish are found off the ba[r]." *C* visualized a stretch of sand, the yellowness being especially noticeable.

"(Sh)ot and shell were poured into the fort." *L* interpreted this as "Bombs and shell." He referred it visually to the naval manœuvers off Santiago. He visualized a "definite circular arrangement of ships in motion." A schematized parabolic curve of a projectile, and a mass of white smoke were also imaged visually.

"[C]aves of great extent honeycomb the hills." *Wh* visualized the side of a hill pitted with small holes.

"[K]een business men perceived the opportunity." *Wh* associated this successively to the name of a leading business man of his native town (auditory-verbal) and visualized the square of business houses in this town.

"[K]ept in damp cellars, the tea soon spoiled." *L* referred this visually to large chests of tea in a warehouse.

"[K]ine were feeding in the meadow." *L* visualized an open meadow with some gray hogs feeding in it. He supplemented verbally: "Five and a half per hundred."

The observers frequently give very minute and exact details of their visual references. A particular part of the environment is taken up into the focus of attention and made especially distinct and clear. This may or may not represent the most significant part of the context.

"[S]and had been heaped upon the track." *Wh* visualized a railroad track about ten feet away and four or five feet long. A heap of sand three or four feet high was piled upon it.

"[T]ubes of brass were filled with powder." *W* misinterpreted *brass* as *grass*, and the latter word gave rise to the visual idea of dusty grass. Later this gave place to the visual idea of a shining brass tube.

"[H]it the nail on the head." *L* visualized a nail and a hammer raised as if to strike it. The sentence was also apperceived in its figurative significance.

"[G]ulls followed in the wake of the steamer." *L* referred this visually to the idea of a bay dotted over with gulls. "Can see them swooping down in their curves." *L* was convinced that this was accompanied by eye-movements.

"[J]og along through life at an easy gait." *L* referred this to a horse trotting along a country road. The rhythmic rise and fall of the haunches and harness were especially distinct.

"The sil[v]er lining is not always obvious." *Wh* visualized a mass of red clouds as seen from a window at which he frequently stands at sundown.

"The mer(c)iful conqueror spared his enemies." This was interpreted by *L* as "The miracle conjurer stared his enemies." It was referred visually to the 'medicine man' of a savage tribe confronted in his practices by a civilized people. "The man had feathers in his hair; his skin was very dark, and a blanket was thrown over his shoulders."

"The wheel had worn a groo[ve] in the iron rail." *W* visualized a finely cogged brass wheel about one inch in diameter. "Forgot all about the rail."

"Before the invalid awoke from his slee[p], the doctor had returned." *L* visualized a patient in a hospital cot. "Everything was neat and clean." The situation was referred to Grace Hospital, Toronto.

"A balmy bree[ze] wafted us to the south." *L* referred this to a trade-wind (probably in verbal terms) and visualized a sailing vessel in tropical seas. "It was a two-masted schooner. The sails were especially prominent and very white."

"The man betrayed his Sco[tch] blood by his accent." *C* referred this to a professor who had told a Scotch story during a lecture. She visualized the man as standing upon the platform, the head and shoulders being the prominent features of the image.

"A mighty shou[t] went up from the assembled multitude." *L* referred this to a Roman mob addressed by Antony. He visualized Antony holding up a piece of drapery to the gaze of the crowd.

"He was wont to bra[g] of his great deeds." *L* referred this to Bob Acres before his duel with Captain Absolute. He visualized a man with a crestfallen expression, pointing at a stile.

"That splendid ru[g] came from the Orient." *L* visualized a map of the eastern Mediterranean, the Archipelago being represented with great detail. Orient was visualized with a capital O. There was a fleeting image of a typical Turk, supplemented by the verbal idea, 'Ottoman.'

"The howling wind set the windows rattling and the doors sla[mm]ing." *W* heard the slamming and the rattling. "The curtains at the window were green." (This last bit of introspection shows how irrelevant are some of the details that come into the focus of attention and occupy a position in consciousness which is quite inconsistent with their significance to the 'meaning' of the sentence.)

"I had often witnessed the scene he had been descri(b)ing." *L* interpreted *descri(b)ing* as *descrying*. The conscious contents had reference to an outlook from a ship's deck,—looking at a distant object through binoculars. *L* also visualized a number of persons "shielding the eyes with the hand;" also the water and a bulwark. With it all he noticed a strain about the eyes,—a 'squint.'

"We were to travel through Europe on bi[c]ycles." *W* referred this visually to a woman of her acquaintance who expects to visit Europe in this way. She saw her climbing a hill on her wheel. "The day was bright and clear."

"On the wall hung a painting and two e(tch)ings." *W* referred this to two long high walls with the pictures upon them. *L* misinterpreted the sentence as, "On the wall hung a picture at two angles." He visualized an unframed screen with a painting upon it. This was standing in the corner and bent to the angle of the corner. "The picture was very large."

"He went into business with his fa[th]er." *L* referred this verbally to a plumber and visualized a dirty-faced, lead-marked man dressed in working cottonades.

"Crou(ch)ing by his side was the faithful dog." *Wh* interpreted *crouching* as *following*, and visualized a man and a dog. "The dog was large; the man poor and shabby. The dog was 'sneaking' along with his head down."

"The roof was supported by an iron bea(m)." *L* misinterpreted *bea(m)* as *prop*. He visualized a building supported from the side by a long pole or buttress. There was a detailed image of a long parallel epipedal iron support. This was supplemented by the idea (modality uncertain) of a wind-storm threatening the building.

17. *The form which the visual reference most commonly takes is that of an ideal reproduction, not of the contextually represented environment as a whole, but only of certain parts of such an environment; the visual idea merely serving to reinforce the general conscious contents which accompany the apperceptive process, and not necessarily forming the focal part of such contents.*

Illustrations: "(Z)eal is not lacking for the enterprise." This was interpreted by *L* as "Steel is not lacking for the enterprise." While the sentence meant to him that "backbone and force were not lacking," he supplemented this interpretation with the visual image of a bayonet.

"[R]eed instruments are replaced by string instruments." *Wh* in this connection visualized an orchestra. The reed instruments were represented by clarionets, the string instruments by violins. These things were reproduced very vaguely. With the same sentence *L* visualized a mouth 'harmonica' and a banjo; *i. e.*, the generic names reed and string were reduced to these concrete objects.

"The army comprised some ten thousand (m)en." *L* misinterpreted *(m)en* as *ants* and later as *tents*. With *ants* the reference was to the militarism of an ant colony. *Tents* gave rise to the visual reproduction of a militia camping ground covered with white tents. "The latter was a definite picture, the former only a word and the image of an ant."

"Con(s)ider for a moment the effects of the measure." This was reported by *L* as, "It bettered for a moment the effects of the measure." *L* visualized a "lot of heads and one man standing up," which represented for him the idea of a legislative assembly.

"We detected a faint odor of [m]usk." *L* imaged a wet muskrat, the long tail being especially distinct.

"The dim[l]y lighted chapel was filled with women." *C* referred this visually to Sage Chapel, Cornell University. *W* referred it to the chapel of a Chicago hospital. *L* referred it to the interior of Sage Chapel.

"The un[m]apped territory of the earth is not extensive." *L* "thought in a general way" of government surveys and visualized two men who are engaged upon the coast survey.

"Ingen[io]us contrivances sometimes earn fortunes." *W* referred this to a new piece of acoustic apparatus in the psychological laboratory. Then, by way of the fall-phonometer which stood near by, the idea of 'slot-machine' was successively associated.

"To touch the he[m] of his garment would cure all diseases." *Wh* imaged a Sunday School chart. *C* visualized a garment with a wide hem.

"The time was ri[pe] for a concerted movement." *L* referred this to Roberts's campaign in South Africa. This reference was partly verbal and partly visual. He pictured Roberts and the outline of a besieged city. The rest was supplemented verbally except for an indefinite mass of soldiery.

"By his si[de] crouched the faithful dog." *W* "saw the dog—a yellowish brown bird dog. He had been mistreated and was cringing." *Wh* visualized a man "and a thin, scrawny dog with its tail between its legs. It was a winter scene."

"Several black ba(ss) were caught in the stream." *L* misinterpreted *ba(ss)* as *bear*. He visualized a black bear and a deer swimming in a stream. The prominent idea in consciousness, however, was connected with the laws forbidding the killing of deer during certain seasons.

"It is often hard to reduce a compound to its ele[m]ents." The verbal reference 'chemical analysis' was probably the prominent part of *L*'s apperceptive consciousness. It was supplemented by a vague visualization of a number of test-tubes.

"The word was not in the voca[b]ulary." *L* referred this to a word in Fechner's 'Elemente der Psychophysik.' He could not remember the word but visualized a page and knew its position on the page. *Wh* with the same sentence visualized Webster's Dictionary.

"The ring was set with ru[b]ies." *L* pictured a ring with a beautiful setting. This was accompanied by the verbal associate 'marriage.' He thought particularly of the coloring of the stone and wondered if it was explainable on the same principle as the coloring of pearls. This involved the visual reproduction of a diagram of dispersion phenomena.

"No one doubts the moral efficiency of re[p]entance." Here the visual reproduction of the gates of the Auburn prison was an accessory part of *L*'s apperceptive consciousness.

"He occupied a roo[m] on the fourth floor." *L* referred this to a

building on the university campus. He visualized the building. *C* visualized the same building. *Wh* imaged a dormitory at Brown University. None appears to have had a definite visual reference to the man or to the room, the building monopolizing the visual consciousness of the time.

"O[v]er the divide was the promised land." *W* thought of *divide* visually as a chasm or gulch. With *L*, *divide* suggested a log-boom in a river. *Promised land* gave rise to the reproduction of picture of Moses on Nebo, which *L* had seen in Sunday School.

"A dea[f]ening roar heralded the disaster." *Wh* visualized an explosion, but heard nothing. With *L*, *roar* suggested a waterfall in visual terms and the sound of a waterfall in auditory terms.

In all the above examples it will be noted that the visual part of the apperceptive consciousness is frequently supplemented by other references, principally verbal in character, all of which function together in apperception. Now this group of conscious elements comes into prominence, now that group, and only the more striking are noted in the introspective reports. As *L* said at the close of one report: "The interpretation involves fragmentary images, now of this, now of that modality. I can note only a few of these, but there are others there." As to the importance of the kinaesthetic elements upon which Bawden[1] has laid so much stress, the results of our experiments permit only of the assertion that the kinaesthetic factors very seldom come into the focus of consciousness. Some of the more typical references of this class are given below:

"(Kn)eel before misfortune if you will." *Wh* misinterpreted (*kn*)*eel* as *yield*. The kinaesthetic concomitants of kneeling and bowing were present.

"[H]unt for the word in the dictionary." *L* experienced the 'feel' of rapidly 'leafing' the pages of the lexicon in hunting for Greek words. He also visualized the face of a man in the library of the University of Toronto,—'a big fellow with a blue coat.'

"[Sh]un evil companions." Here *L*, along with a verbal and visual reference to a Sunday School, experienced an auditory-kinaesthetic reproduction of a Sunday School song.

"[J]oy and sorrow are sprinkled about equally among men." *Wh* "interpreted *sprinkled* by a centrally-excited arm-movement idea of scattering seed."

"Har[m]onious relations have been established." *Wh* reported in the protocol: "'Harmonious relations' means a smoothing over; this in my consciousness is the image of an outward movement of the hands."

"The care of the tee[th] is a matter of importance." *Wh* experienced the kinæsthetic concomitants of brushing the teeth.

"He was not su[re] of the matter." *L* visualized a person perplexed; *i. e.*, with certain characteristics of the face denoting perplexity, such as the drawing together of the eyes and a general tension. *L* reproduced such an adjustment.

"One often feels the nee[d] of exercise." *Wh* referred this to the idea of bicycling. In this idea the kinaesthetic elements were predominant, but they were supplemented by verbal and visual elements.

[1] Bawden: *op. cit.*, pp. 65 ff.

He imaged himself as coming up a sharp incline near the university library. Just before hearing the sentence he had been conversing about bicycling.

"Every man possesses an ele[m]ent of the divine." In this connection *Wh* experienced a kinaesthetic 'upness' supplemented by a vague visualization of clouds and the verbal idea, 'God.'

"He was unable to maintain his po[s]ition." *L* referred this to the situation a public lecturer would be in if his position was assailed. This reference took form in "internal disturbances, such as quailing."

"Gri(p)ing pains preceded death." *L* misinterpreted *gri(p)ing* as *lying*. He had a verbal and kinaesthetic reference to a death struggle. This involved centrally excited muscle and strain sensations.

"Bo(wl)ing is an excellent exercise." *L* misinterpreted *bo(wl)ing* as *rowing*. He referred the sentence to an experience in camping, the prominent part of the recollection being the 'feeling' of a well muscled arm.

"He was wrapped in the soundest slee[p]." *L* visualized a man wrapped in a blanket, and referred the sentence to the idea of calmness and rest in terms of muscular relaxation.

"It is said that there is always roo[m] at the top." Here again *Wh* experienced the kinaesthetic idea of 'upness.'

"As a joke it was simply hu[ge]." *Wh* noted a "motor laughter fringe" as a prominent part of the apperceptive consciousness.

Purely auditory supplements are met with in the reports much more infrequently than kinaesthetic supplements, and it may be inferred that they very seldom come into the focus of attention during the apperceptive process. A few examples are given below:

"He had been shot through the chest, and lay on the ground wri[th]ing." *L* referred this to a wounded soldier; he "seemed to hear him groan."

"They were almost stunned by the concu[ssi]on." *L* imaged the sound of blasting, and accompanied this with a motor adjustment about the face.

"The concussion was dea[f]ening." Here *W* experienced a "peculiar sensation in the ears."

"The man betrayed his Sco[tch] blood by his accent." *L* imaged a large, freckled-faced Scotchman; "seemed to hear a Scotch 'twang.'"

In the sentences already cited, "Not a man ha[s] had his vote refused him," and "A dea[f]ening roar heralded the disaster," *L* reported auditory references, in the first case to the noise of a city on election night, and in the second case to the roar of a waterfall.

Taste and smell elements may be said to play a very unimportant part in the ordinary apperceptive consciousness. The following sentences gave the only instances of such references.

"Diseased tissues are studied by pa[th]ologists." *W* referred this to the idea of a biological laboratory. This was mainly visual but was supplemented by a centrally-excited olfactory sensation.

"The fire was almost smo[th]ered." *L* visualized a dense black smoke. He experienced a stifling 'feeling' in his throat and nose, and reproduced ideally the odor of smoke.

"We detected a faint odor of [m]usk." *L* ideally reproduced a vague and indefinite musk odor.

"(J)am is generally liked by the small boy." *Wh* misinterpreted

(*j*)*am* as *ham* and ideally reproduced a faint taste of ham. (This was just before the lunch hour.)

Temperature elements were noted in only two instances:

"The winter came and the river fro[ze]." *W* had a faint ideal reproduction of a sensation of cold.

"The howling of the wolves disturbed our slee[p]." *L* visualized a mountain side covered with snow. This idea was supplemented by temperature images.

18. *Verbal ideas exist more frequently as associative or contextual supplements than as the focal objects of the apperceptive consciousness.*

Illustrations: "[D]eeds of kindness are seldom appreciated." *L* visualized a person of his acquaintance who proved himself ungrateful for a service rendered him. This was verbally supplemented by 'ingratitude.'

"The navy consisted of two ships and a bri[g]." *C* was unable to remember the distinguishing characteristics of a brig. She visualized a Norwegian barge of ancient type and verbally supplemented the date '418.'

"The siege was interrupted by a tru(ce)." This was misinterpreted by *L* as "The speech was interrupted by a True." *True* meant to him the name of a man. It was associated with 'Blue,' the name of a French Canadian partisan.

"[T]ips from good authorities cause some activity in the market." Aside from a focal visual reference, *L* supplied the verbal supplements 'wheat,' 'board of trade.'

"[H]old fast to that which is good." *L* associated the names 'Paul,' 'New Testament.'

"[Sch]ools of fish were found off the bar." *L* visualized a fleet of smacks off Newfoundland in a fog. The nets were tangled and the fish could be seen through the meshes. The word *school* was taken in its educational significance and was supplemented by a vague visual idea of a schoolhouse—a large stone building.

"(J)ute is a product of the tropics." (*J*)*ute* was misinterpreted by *L* as *Juch*. This word was referred visually to a picture of Emma Juch, the opera singer, and was verbally supplemented by the words, 'Toronto Opera House.'

"The pur[p]ose of religion is ethical." *Wh* referred this verbally to 'Tarde.'

"The still[n]ess was appalling." *Wh* verbally associated the terms 'lake,' 'solitude.'

"The chau[g]es in the course were misleading." *L* visualized the catalogue of Toronto University and supplemented it verbally with the word 'curriculum.' *L* also visualized the peculiar expression on the face of an old professor who remarked that one could find nothing that one wished to find in a university catalogue. "The face was all screwed up."

"An an(ci)ent proverb is often a modern fallacy." *L* first interpreted *an*(*ci*)*ent* as *Indian*, and immediately supplemented verbally the phrase: "The only good Indian is a dead Indian." This suggested that the white man's proverbs are often fallacies, and then *ancient* suddenly came up to replace *Indian*.

"The army was sa[fe] behind its trenches." *Wh* had a vague visualization of a trench filled with men,—probably a reproduction of a newspaper sketch. This was verbally supplemented by 'Boers.'

"It was rumored that the war was o[v]er." *Wh*'s first reaction was

verbal, 'Boers.' *L* visualized a mass of soldiery and verbally supplemented 'Roberts.'

"The flocks were watched by she[ph]erds." *W* visualized a Sunday School card and verbally supplemented the phrase: "Shepherds watched their flocks by night."

"I caught the words he was dro[pp]ing." *L* referred this (in predominantly visual terms) to one person in an auditorium listening to another speaking at a long distance. This was supplemented verbally by 'heavy.'

19. *When the verbal ideas occupy the focus of consciousness, they usually take the form of antithetical or explanatory clauses. Such clauses are sometimes found as the verbal supplements of the focal idea. The sentences which lend themselves most readily to these antitheses, completions, and supplementings, are usually short sentences which arouse a minimum of visual imagery, and in which the affective element is strong; they often awaken in the hearer an attitude of dissatisfaction, a mood of humor, or a 'feeling' of incompleteness.*

Illustrations: "[P]uns are jokes of a low order." *L* immediately added, "And therefore discredited as witticisms."

"[H]eed the advice of an elderly woman." *Wb* supplemented: "Pity the sorrows of a poor old man, but heed the advice of an elderly woman."

"We did not see the train approa[ch]ing." *W*'s immediate reaction: "Were they run over?" Then came a visual reference to a kinetescope reproduction of a railroad collision. The kinetescope films were running backwards.

"His death must be reported to the au[th]orities." *L*'s verbal reaction, "Yes, death and birth registrations are compulsory."

"To slee[p]: perchance to dream: ay, there's the rub." While the phonograph was repeating the sentence, *Wb* said to himself, "He's quoting Shakespeare."

"In her arms she held the ba(be)" *L* pictured *in her arms* as a printed phrase. Later there came up, "In her arms she held the *bay*." *L* could not tell how this came; he "heard *babe* very distinctly." As a matter of fact, *ba(be)* was mutilated and sounded *bā*. *Bā* must have been present in the fringe of consciousness, but before it came into the focus it had been associatively supplemented into *babe*. Then the original impression became focalized and *bay* was apperceived.

"The scientist may claim his kinship with the a[pe]." *W*'s first reaction: "A preacher must have said it."

"One man broke a rib and a collar-bo[ne]." *L* visualized a rib and verbally supplemented the sentence with the phrase: "Pretty badly damaged. How? By a fall? Accident? Intentional?" "Platitude.

"A loss will always be greater or le[ss]." *L's* reaction: What of it?" Affective tone, very unpleasant.

20. *Occasionally the observer's apperceptive process anticipates the succession of symbols constituting the objective stimuli and forming the spoken sentence. This phenomenon is probably often unnoticed because the premature apperception tallies with the complete interpretation; but sometimes this coincidence fails, and the observer is conscious of a distinct 'bias' for another form of completion,—a bias which frequently expresses itself in verbal terms.*

Illustrations: "Of all that little band of men, he was the bra[v]est." *C* did not hear *band of men* distinctly, and misinterpreted it as the nonsense word, *valment*. She wished, however, to insert *regiment* and would have done so, had the sounds which she heard warranted it. The word *regiment* was consciously present as an incipient laryngeal innervation. She felt it "echo and re-echo in her throat."

"One cannot deny that most office holders are ra[p]acious." *Wh*, *C*, and *L* wished to make it *post-office* instead of *most office*. This is simply a prejudice in favor of a more familiar combination of sounds.

"The hedge needed pru[n]ing." *Wh* had already supplied *trimming* before *pruning* was perceived. He had also visualized a hedge around a small white house. This last was a boyhood recollection.

"He had left word that he would be extremely bu[s]y." Before the last words were perceived by *W*, she had already supplied "would not be at home."

"For conquest he had a strange i(tch)ing." *L* misinterpreted *i(tch)ing* as *aim*, but had a prejudice in favor of *ambition* and with this verbal idea had already supplemented a visualization of Bonaparte.

"That the man was bra(ve) no one could deny." *C* wished to say, "That the man was to blame, etc.," but she misinterpreted *man* as well as *bra(ve)*, and finally reported the sentence, "That the demand was blame, no one could deny." This was referred visually to an absconding official whose defalcation was just then the sensation of the hour.

"He desired to li[ve] in luxury while he could." *Wb* "wished to make it come out something about the 'lap of luxury.'"

"No one dared to lau(gh) at the situation." *Wb* tried to make it into: "No one dared to analyze the situation."

"Not one in te[n] knew of the transformation." *C* would rather have said *transaction*, which would have meant to her "a change in partners."

"That the movement was ra(sh) could not be denied." *Wb* visualized an army manœuvering in the field and supplemented the word 'Boers.' He had an impulse to make the mutilated word into *rare*. He "heard the two sentences pass through his mind."

"The fa(th)er who is wise may use the rod." *Wb* first interpreted *fa(th)er* as *farmer*, and expected the sentence to be," The farmer who is wise may do so and so." When *father* was supplied, the phrase, "Spare the rod and spoil the child," was supplemented.

"The co[ll]ar which he wears is number sixteen." *W* had anticipated "The collar was soiled," and had visualized a soiled collar.

21. *In the observers tested, reactions which were 'professional' in character were almost always verbal in form.*[1]

Illustrations: "The light was di[m] and faltering." *Wb* had a vague visualization,—"too faint to describe." Afterwards he thought, largely in verbal terms, of the difficulty of getting a standard illumination in experiments upon optics. *C* referred the same sentence to the construction of the laboratory dark room.

"Pleasure and pai[n] are the extremes of feeling." *L* "figured 'p-p' in print" as his note-book abbreviation for 'pleasure-pain' theor-

[1] *Cf.* Stanley, H. M.: Language and Image, *Psychological Review*, Vol. IV (1897), p. 71. *Cf.*, also, Philippe, Jean, *Revue Philosophique* Vol. XLIV (1897), p. 523: "Moins les images sont nombreuses, plus elles sont concrètes; elles se généralisent et perdent leurs caractères individuels et particuliers à mesure qu'on les renouvelle."

ies. He associated a verbal supplement: "Many think that pleasure-pain is everything in feeling."

"Re(p)entance is not in itself constructive." *L* interpreted the first word as *re-entrance*. He also verbalized the logical definition of mental construction.

"Pro[v]ing another's error is a negative process." *L* visualized *error* as a printed word, and associated the sentence with the idea of negation in Hegel's dialectic. This was largely in verbal terms.

"Phi(l)istinism is a latter-day virtue." *L* misinterpreted *Phi(l)istinism* as *Christianism*; *Latter-day* suggested *saints* and the expression in 'Hebrews,' "These latter days." *L* visualized this in print (Greek), and translated it verbally into English. He "saw it on a page of his Greek testament."

"Phi[l]osophy is the matrix of science." *Wh* associated this in 'thought' terms with Spencer's doctrine of the relation between science and philosophy.

22. *Certain 'turns of speech' are constantly referred to certain uniform 'sets' or patterns of ideational material. Such sets or patterns may be called 'constant supplements' or 'type associates.'*[1]

Illustrations: "[S]ales of wheat were very large." Whenever the term *wheat* is used in this or in a similar connection, *Wh* visualizes a farming scene in the northwest,—a reproduction of a picture in his school geography.

"[T]ips from good authorities caused some activity in the market." With the word *tips*, *L* constantly images a man's hand in a 'sly' position, as if handing money to a waiter.

"[T]ops of distant mountains could be seen." The word *mountains* with *L* is constantly supplemented by a visualization of a distant range of mountains which he once saw in Manitoba. "They are hazy in the distance."

"[F]ame does not always accompany poverty." *L* notes that he constantly refers *fame* to the visual idea of Lincoln as a farm-hand.

"[Sch]ools of fish were found off the bar." With references to *sea*, *Wh* constantly associates a stretch of green water bordered by a narrow strip of yellow sand.

"[C]aves of great extent honeycomb the hills." *L* constantly supplements the word *honeycomb* with the visual idea of Hell Gate rock artificially honeycombed for the blasting powder which is to destroy it. He pictures the rock "bored by a great system of holes and elaborately charged for explosion."

"[K]een business men perceived the situation." With *keen*, *L* constantly envisages a knife blade about two inches long and very sharp.

"The Irish[m]an is famous for his ready wit." With *Irishman W*'s constant supplement is the visual idea of a bricklayer with a red beard supplemented by the auditory idea of a pronounced brogue.

"The in[f]inite reaches of space baffle the imagination." With

[1] Galton has called attention to this phenomenon. *Cf.* Inquiries into Human Faculty. London, 1883, pp. 157 ff. *Cf.*, also, cases cited by Whipple, G. M., this *Journal*, Vol. XI, No. 3 (1900), p. 391; also Philippe, *op. cit.*, p. 524: "Cependant il faut bien noter que cette tendance à la généralisation se fait jour dès l'entrée du groupe d'images et semble se manifester tout d'abord par la tendance d'une certaine image à dominer toutes les autres et à les absorber. Il se forme en quelque sorte un centre de généralisation, vers lequel convergeront naturellement les images à venir."

infinite, *W* always experiences a centrally-aroused blackness of great extent, in the center of which she is standing. *Infinite time* is a river flowing very slowly—"not another thing around it."

"Yon[d]er is the library building." With *yonder*, *L* constantly visualizes a hand pressing forward. With *mystery*, *L* experiences a centrally-aroused blackness.

"Drin[k]ing-water should be boiled." *L* referred this verbally to 'Toronto.' With *Toronto*, he has the constant visual supplement of the city as seen from the water-front.

"The dim[l]y lighted chapel was filled with women." *L* referred this to Sage Chapel, Cornell University. In this connection he associated verbally 'President Schurman.' This name is constantly supplemented by the image of a large man in gray clothes. (*L* had at that time never seen President Schurman.)

"The religious spirit is predominantly e[m]otional." *W* verbally associated "shrine" which brought up its supplement,—the image of a figure kneeling before a confessional.

"Gluttony is an euphemism for stu[ff]ing." *L* has the constant verbal supplement 'Sir Walter Scott' with *euphemism*. It was in one of Scott's novels that *L* first saw the term.

"He went into business with his fa[th]er." With *business*, *Wb* constantly envisages the business square of his native town.

"He was lost in a ma[ze] of verbalism." *L* verbally associated 'logomachy' and visualized a person "throwing off words that did n't mean anything." This led to the verbal associate 'tongue-tangle' which brought up its constant supplement, the visual idea of a mass of knotted thread.

"Fe[tch]ing and carrying is the portion of the slave." With *slave*, *W* always visualizes a stout negro and the background of a southern plantation house.

"The structure was simply stu[p]endous." With *stupendous*, *L* associates the image of a high cliff. With *decision*, *L* sees Cromwell's face, particularly the lower jaw.

"Clo[th]ing is necessary in cold climates." *Wb* has with *cold*, a constant reference to a picture in his school geography representing an Arctic scene.

"Be[y]ond matter is spirit." With *beyond*, *L* constantly visualizes a chasm.

23. *Particular parts of a context are often visualized as printed, or heard out separately ('auditized'). This usually occurs (a) when there is a conflict between two words which resemble one another in sound, (b) when a word is quite unfamiliar, and (c) when the word is very important to the 'meaning' of the entire sentence.*

Observers of the auditory type tend to hear the word spelled out or pronounced very distinctly, observers of the visual type tend to see it printed. It is obvious that both these operations tend to concentrate the attention upon the word in question. In the visually minded observers, the attention is more easily fixed upon visual ideational elements than upon auditory ideational elements, hence the tendency to translate the sound-symbols into visual symbols. *L*'s ability to see clearly only part of the word at a time,—three or four letters at the most being simul-

taneously distinct,—is in accord with Raymond Dodge's[1] results in the analysis of the verbal idea.

Illustrations: "Di[v]ersity of interest may not be a bar to friendship." *L* visualized *diversity*, *interest*, and *friendship*. The latter gave a particularly distinct *fr* at the beginning; the rest not so clear.

"The re[v]elation of the universe may be variously interpreted." *L* found flaws in *revelation* and *variously*, which led him to visualize both words as printed.

"The older animals are harder to ta[me]." *L* visualized animals, *ani* being especially distinct.

"As a Russian he was a typical Scla[v]." *L* visualized *Russian* with an especially large *R*. *Sclav* was also visualized, *v* being very clear. All this was immediate with the sound of the words.

"It was a remarkably clever tra[p]." *L* visualized *ark* of *remarkably*.

"He seemed to te[ll] the truth." *C* imagined the magazine 'Truth,' visualizing the title very distinctly. Immediately afterward, *truth* was reproduced auditorily.

"It was an ele[m]ent of which the community was well rid. *L* imaged the *ele* of *elements*.

"The dogs were held in lea[sh]." *C* was not familiar with the term, *leash*. She had heard it before, once or twice at most. She "had a tendency to spell the word out."

"They went early to avoid the ru[sh]." To *L*, *went* sounded like *wept*. *Went* was finally confirmed by the context and was then visualized and auditized.

"The idea was very va[gue]." *L* visualized the word *idea*, and noted a tendency to put *r* on the end of it.

24. *With certain types of sentences the references of the various observers are approximately identical. These are usually (a) sentences in which the 'meaning' is unequivocal; (b) sentences in which a certain word or 'turn of speech' suggests a familiar proverb or stereotyped phrase; and (c) sentences which refer to local or common objects and events.*

This identity of reference was not met with frequently, and this fact leads one to doubt Stout's[2] conclusion that language as a means of communication "serves to fix the attention of the hearer on the ideally represented objects present in the mind of the speaker." At least such a statement is only part of the truth. Symbolic communication serves indeed to transmit the experience of the speaker to the hearer, but the manner in which the speaker's 'meaning' is taken by the hearer is conditioned entirely by the hearer's own experience. Language does not fix the attention of the hearer upon the experience of the speaker; it rather places the hearer in an ideally constructed experience which approximates—and generally only very roughly—to the experience of the speaker. This fact is more clearly shown under 25, below.

Illustrations: "By his si[de] crouched the faithful dog." *W*, *L*

[1] Dodge, R.: *op. cit.*, pp. 14-15.
[2] Stout, G. F.: A Manual of Psychology. London, 1899, p. 452.

and *Wb* all visualized a man with an ill-kempt dog cringing at his feet. In *L*'s visualization the man was represented as dead.

"A sulphur or a vapor ba[th] is recommended for the complaint." *L* and *Wb* imaged a vapor bath cabinet such as is advertised in the magazines.

"The evil will remain as lo[ng] as men are human." *L* and *C* immediately associated verbally the proverb, "To err is human, to forgive, divine."

"The bank was slo(p)ing." *L* and *W* misinterpreted *slo(p)ing* as *closing*. Each visualized a familiar bank building. *L* supplemented his visualization by the verbal associates, "Saturday, one-o'clock, too late."[1]

"The structure was simply stu[p]endous." *Wb* at first referred this indefinitely to Ramón y Cajal's schema of the chiasma. Later he visualized a 'sky-scraper' in New York. With the same sentence *L* visualized a Chicago 'sky-scraper.'

"The voca[b]ulary is an important part of the book." *L* and *W* referred this visually to the first Latin exercise books which they had used.

"They shou[t]ed lies to each other across seas of misunderstanding." *W*, *L* and *Wb* each supplemented this sentence with a visual reference to the ocean.

"They are goods which will wa[sh]." *W* visualized the interior of a store. A salesman was impressing upon a customer that the goods would wash. The counter was covered with blue ginghams. *L* visualized a similar scene, but not with such detail; he supplemented this with the verbal idea 'fast colors.' *Wb* visualized the interior of a store. The counter was a little to his left. The goods—cheap dress goods—were laid out in rolls. The clerk was bending over the counter and earnestly making the statement that the goods would wash.

25. *The imagery which apperception involves is not always consistent with the significance of the context; yet this does not necessarily mean that the significance is inadequately apperceived.*

The ideally reconstructed environment, if visual, may include objects the absence of which the speaker clearly intended the sentence to indicate; or there may be in the field of the apperceptive consciousness a complex of irrelevant elements. Stout[2] says that the "word only calls up what is relevant to the controlling interest of the thought," but what is relevant differs with speaker and hearer. In both cases it is determined by the 'personal equation,' by differences in experience, by the quality of the 'apperceptive' material.

Illustrations: "They were skating on the i[ce]." *L* visualized the surface of Lake Cayuga, unfrozen.

"The judge wore the ermine ro[be]." *Wb* visualized a man representing the judge, but the details of his costume did not come into clear consciousness.

"They were woven on an old-time loo[m]." *W* referred this to a modern woolen-mill.

"Pollu[ti]on of the ballot is the curse of democracy." Here *L* had a verbal reference to 'ballot,' but visualized muddy water.

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[1] *Cf.* Dodge, R.: *op. cit.*, p. 11.
[2] Stout: *op. cit.*, p. 462.

"The council chose the si[te] for the new building." *Wb* referred this in a vague way to the Common Council of Salem, Mass. He visualized a building in Ithaca, but not a public building.

26. *Distraction of the attention militates against the complete apperception of the meaning of the sentence. This distraction is frequently caused by some peculiarity in the mechanism of the sentence, such, e. g., as the mutilation of an important word.*

While this principle as formulated above is an induction from the introspective data, it would follow *a priori* from our conception of apperception as the functional aspect of attention. In many of the instances which are cited below, the observer has 'a vague idea' of what the sentence means. They might be called instances of an incomplete or partial apperception, and no small part of our communicative experience is probably of this kind. As a rule, however, both the efficient expression of symbols and the efficient interpretation of symbols are possible only under stress of the attention: the processes involved seldom become automatic, and when automatic fail to function with efficiency.[1]

Illustrations: "The evil will exist as lo[ng] as the race is human." *Wb* repeated the sentence mechanically, but it was characterized by him as "only words;" it aroused no associations. The attention was distracted throughout.

"It was a mo[m]ent that was most impressive." *Wb* "kept thinking of the voice; it sounded excited; had no apperception of the meaning."

"The cloth will fa[de] if exposed to the sunlight." *Wb* reports his attention at a low ebb. He did not hear *cloth* or *fade* until the sentence was finished. Afterward he visualized the place at his home where fabrics are bleached by being spread upon the grass and exposed to the sunlight.

"The la(d) was fresh from the country." *Wb* first supplied *lad*, which he reported, then *lass;* then he returned and substituted *lad*. This operation absorbed his attention, and he had no definite reference for the sentence.

"To win the be(t), he had sacrificed his good name and character." The attention of *Wb* was absorbed by the mutilated word *be(t)*. Although he finally filled it out correctly, he could not analyze the process. "There was present some sensory content, but it was very vague. The whole process appeared to be verbal."

"He left the prisoner to his fa[te]." *W* was distracted by the tone of the voice as reproduced by the phonograph, and did not apperceive the meaning of the sentence.

"The sermon was unconscionably lo[ng]." *L's* attention was centered upon *unconscionably*. He pictured the word in print, and referred to various efforts at pronouncing it. One man was visualized in particular. The general import of the sentence was entirely missed.

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[1] H. H. Bawden (*op. cit.*, p. 120,) has emphasized the importance of attention in verbal expression: "Conscious experience is a constant disturbance of the tendency toward equilibrium between the automatic and attentional processes. Errors, or lapses, appear in the readjustment in the tension between these two processes."

27. *Familiarity with the sentence sometimes militates against a clear and definite reference on the part of the observer.*

Illustrations: "[D]eath is a beneficial thing, biologically." *Wh* had heard the sentence spoken into the phonograph, and after the first few words paid no more attention to it. "All associations seemed swallowed up by this one reference to the previous hearing of the sentence."

"The use of rou[ge] is pardonable only in the green room." *Wh* had already heard the sentence and "experienced a feeling of 'dead familiarity' with it." He had, however, a very vague visualization of the stage of a familiar theater; this was supplemented by the image of a woman of his acquaintance who uses perfumes.

"Obli[g]ing individuals are generally poor." *L* reports the sentence as having a 'familiar feel.' It aroused no definite reference.

"Be[y]ond matter is spirit." The thought was familiar to *W*, and aroused no definite reference.

28. *A characteristic feature of the apperceptive consciousness is the constant change of its pattern to meet the changes in the context.*

In many sentences, the reference which the first few words arouse is inconsistent with the succeeding parts of the context; the supplementing of one word or phrase fails to supplement the sentence as a whole: the observer is in one attitude, has one adaptation, at one point in the sentence; at another the attitude changes, there is a new adaptation and a new shift of the mental scenery.[1]

Illustrations: "That the man was brave, no one could deny." *Wh* first interpreted the sentence as, "That the man was gray, no one could deny." This was unsatisfactory and led to a new construction. *Brave* seemed to "struggle up from the inside of the head and come to the front."

"The wheel had worn a groo[ve] in the iron rail." *Wh* at first referred *wheel* visually to a bicycle. When *groove* was heard the reference was changed to the idea of machinery. When *rail* was heard, a railroad was visualized and later a street-car track.

"He had not yet lost fai(th) in the enterprise." *L* misinterpreted *fai(th)* as *a day*. At first he referred the sentence visually to a man diligently at work; this was before *enterprise* was spoken. With *enterprise* "the conscious reference assumed another setting which expressed itself in the thought that the man had put no time at all into the undertaking."

"The king's ro(be) was yellow." *L* misinterpreted *ro(be)* as *row*. He referred visually to the king's row of tombs at Westminster Abbey. Later *row* was apperceived as signifying a boat, and a long yellow shell was imaged.

"The fifty-ton sloo[p]-of-war captured a frigate." *L* referred this to a

[1] *Cf.* Stern, L. W.: (Psychologie der Veraenderungsauffassung. Breslau, 1898, p. 147.) "However sovereign the spontaneity of attention is as regards constant sensations, it is just as dependent upon the changing ones. Determined by central factors, it directs itself toward the former; the latter compel it to themselves. They are themselves motives of the adjustment of attention."

naval engagement. He visualized Paul Jones with a 'cocked' hat. *Sloop* was supplemented by the visual idea of a single masted sailing-ship. This dropped out of consciousness with frigate, and was replaced by the idea of two large battle-ships.

"Several black ba(ss) were caught in the stream." *Wb* at first misinterpreted *ba(ss)* as *bear*. He visualized in this connection a small black bear and a forest background. When *stream* was heard, he substituted *bass* for *bear*. The forest setting still persisted, but a hook replaced the bear as a center-piece.

"The rai(l)ing was washed away." *L* misinterpreted *rai(l)ing* as *rain* and referred it to the visual idea of sand washed away by rain. Later *rain* was changed to *railing* and supplemented by the image of a ship on a very rough sea.

"The king was forced to be(g)." *L* misinterpreted *be(g)*, first as *bed* which he supplemented with the idea that the king must have been under the influence of some very strong character. Then *bed* was replaced by *back*, supplemented by the idea that the king was in danger of assassination; this took form in a visualization of a man coming before the king on horseback.

28. *When there is doubt of conflict as to the meaning of a sentence, the apperceptive consciousness is predominantly unpleasant. If the apperception of the meaning is clear and distinct, the affective tone is generally pleasant. This is apart from the intrinsic affective tone of the sentence as such, which may be pleasant unpleasant, or indifferent.*

Sentences the apperception of which was accompanied by a pleasant affective tone:

"That the man was bra[ve] no one could deny." *Wb* "felt satisfied" because he got the interpretation easily and correctly.

"Every one expected a dro[p] in the market." *Wb.* (Referred to a humorous incident.)

"Brute and ma[n] are one in their physical structure." *Wb.* ("Liked the sentence because of its length." The preceding sentences had been very short.)

"The re[v]elation of the universe may be variously interpreted." *L.* (No reason given.)

"Pou[r]ing oil on troubled waters causes them to subside." *W.* (No reason given.)

"The first horse had passed the po[le]." *L.* ("Thought of trotting race and horses neck and neck." When *pole* was heard he wished to replace it with *line*. Then he remembered that the term *post* was used in the same connection. This changed the affective coloring from unpleasant to pleasant.)

"Wi[th]out health, happiness is perhaps impossible." *Wb.* (Did not supply *health* until the sentence was completed. When it came it was accompanied by a pleasant affective tone.)

Sentences the apperception of which was accompanied by an unpleasant affective tone:

"He had lost ho[pe] in the unequal struggle." *Wb.* ("Felt sorry for the poor beggar.")

"The invalid should be fe[d] on weak broth." *W.* (Observer "dislikes broth.")

"By his si[de] crouched the faithful dog." *W.* (No reason given.)

"Sla[mm]ing doors is a trait of childhood." *W.* (No reason given.)

"Fi(r)ing too high is a common mistake." *C.* (Aggravated because she could not apperceive the meaning. She noticed a general tension in trying to get a word for *fi(r)ing*,—a strain about the eyes and chin.)

"The loss will be greater or le[ss]." *L.* (Proposition trivial.)

"The milk was brought in a ju[g]." *L.* (Unpleasantness came with the idea of milk, which was visualized a pale bluish-white fluid.)

"The idea was very va[gue]." *L.* (Observer reproduced ideally the condition he feels himself to be in when baffled by an idea. It is an unsatisfactory 'groping,' with a large affective coloring of unpleasantness.)

"The navy consisted of two ships and a bri[g]." *W.* ("It was so insignificant.")

"As a joke it was simply hu[ge]." *L.* (Last word uncertain. Feeling of bafflement, curiosity and disappointment, followed by pleasure when the word was finally supplied.) *Wb.* ("Had a 'motor laughter fringe' on hearing the sentence.")

In planning this investigation, we had intended to determine as nearly as possible the point in the sentence at which the apperception is completed. To this end, sentences were to be given to the observers, at first with the final word cut out, then the next, and so on until the implication of the sentence was entirely lost. Then the sentence was to be built up from the beginning, first one word being given, then another and then another until the 'thought' was complete. It was found, however, that this procedure would require a greater number of observers than was available; hence the test was left incomplete. The following statements may, however, be made: (1) The omission of the final word causes practically no disturbance to the apperception of the sentence, either the word itself or its meaning-equivalent being readily supplied by the observer. (2) Proposition 20 seems to indicate that apperception is completed early in the sentence. (3) Proposition 1 affords a certain confirmation of this hypothesis. (4) The whole trend of the introspection recorded during the second part of our experiment is to place the act of apperception early in the sentence.

We had also planned to determine the relative importance of the various parts of speech to apperception. So far as the mutilations are concerned we are able to say that 'contextual supplementing' is not a function of the syntactical character of the word.

29. *In general: The consciousness concomitant with the apperception of auditory symbols is made up of sensational and affective elements—some peripherally, some centrally aroused—in connections which vary in character with different individuals and under different conditions. These connections are arranged in patterns which change rapidly into one another, and are in general transitory and fleeting. When the attention is directed to the peripherally excited elements exclusively—when the external stimuli occupy the burning point of apperception—the meaning which they as symbols should convey is not clearly apperceived. When the attention is directed upon the centrally aroused ideas which the symbols suggest, the 'meaning' is apperceived, but errors and lapses in the stimuli are apt to pass unnoticed.*[1]

Stout[1] in his exposition of 'implicit apprehension' says: "The mental state which we call *understanding the meaning of a word* need not involve any distinction of the multiplicity of parts belonging to the object signified by it. To bring this multiplicity before consciousness in its fullness or particularity would involve the imagining of objects with sensory qualities, visual, auditory,

[1] Stout, G. F.: Analytic Psychology. London, 1896, Vol. I, Ch. iv, pp. 78 ff.

tactual, etc. But it has often been pointed out that in ordinary discourse the understanding of the import of a word is something quite distinct from having a mental image suggested by the word." And so the concept of 'implicit apprehension'—the apprehension of form without the apprehension of content—is introduced to explain the phenomena of symbolic apperception. Stout, however, goes too far when he says that there is "no absurdity in supposing a mode of presentational consciousness which is not composed of visual, auditory, tactual and other experiences derived from, and in some degree resembling in quality the sensations of the special senses; and there is no absurdity in supposing such modes of consciousness to possess a representative value or significance for thought, analogous in some degree to that which attaches to images, just as revived images may have a representative value in some degree comparable to that of sense-perceptions, in spite of very great differences in respect to distinctness, vividness and quality." From the series of observations which were made in the course of our experiment, no conscious 'stuff' was found which could not be classed as sensation or affection, when reduced to its ultimates by a rigid analysis. Neither do our experiments show that there is in the apperception of spoken sentences such a thing as 'imageless apprehension.' They show rather that the consciousness concomitant with symbolic apperception is in a state of attention, where certain constituents are clearer and more distinct and certain other constituents more obscure and less distinct; and that among the more distinct constituents, among those which occupy the focus of attention, there are always some—whether they be verbal, visual, kinaesthetic or what not—that are definitely tangible, and that can be reported by introspection.

It is true that Hobbes, Berkeley, and Dugald Stewart,—all of whom are quoted by Stout,—found it difficult to make the apprehension of symbols consistent with a sensational psychology. But these men lived and wrote before the function of the verbal idea in 'thought' processes had been thoroughly exploited; before its kinaesthetic nature had been pointed out; before the current doctrine of attention with its biological implications had been suggested; and before recognition and recollection had been differentiated in the memory process, and referred to spatially, structurally and genetically different areas in the brain cortex. It is now generally admitted that direct recognition does not necessarily involve the conscious comparison of the presentation with a memory image, and the subsequent formation of the judgment 'alike' or 'different.' And the apperception of symbols signifying bits of experience may, quite legitimately, involve a form of direct recognition, more

complicated, it is true, yet similarly devoid of any complex of visual images. But this does not imply that the apprehension is 'imageless,' in Stout's connotation of the term. Recognition is not a structural element, but a process in which certain elements unite to form the recognitory consciousness, to carry the function of recognition. But these elements are either sensations or affections. Stout's 'implicit apprehension,' on the other hand, postulates a non-sensational, non-affective element, —a schema, a form without content, a structural something that can in no way be reduced to modal elements.

The relation of apperception to attention suggests a biological significance that may do much toward clearing up these problems. Apperception is the functional side of attention, and attention is the mental aspect of organic adaptation.[1] The new is not apperceived by the old in the Herbartian sense: the new arouses a typical attitude, an attitude in which the organism faces the typical environment which the new symbolizes. We may say with Stout that the new is referred to a mental 'system,' in so far as such a system is a mood, an attitude, a tendency, an adaptation. The mind adjusts itself uniformly to uniform conditions: this seems to be the essence of the apperceptive 'mood.' When *C* in the sentence "The play was bad," interpreted play as a drama, her mind adapted itself in a degree to the drama environment. This was not necessarily a focal reference to a given play, but the mind was in the dramatic 'mood.' Should particular parts of a typical play-environment have been ideally reproduced, the situation would only have been reinforced. Should certain verbal ideas such as 'drama,' 'theaters,' 'Shakespeare,' etc., have been reproduced in consciousness, either visually, auditorily or kinaesthetically, these ideas would have been constituents of the dramatic 'mood,' but not necessarily the fundamental constituents. The fundamental constituents may and do vary from time to time. Only very seldom can they be called constant, and the 'constant supplements' which we have noticed are instances of such occasions. The fact that the focal constituents of the apperceptive consciousness are not necessarily consistent with the situation represented bears testimony to this point of view. "There was not room for a stove in the corner;" with this sentence one observer imaged distinctly a stove in the corner of a small, otherwise bare room. His own surprise at the inconsistency of this imagery was shown by his exclamation upon reporting the introspection: "But there *was* a stove there!"

In symbolic apperception, the function of language is to reproduce the appropriate mood, the consistent attitude, the more

[1] *Cf.* Titchener: *op. cit.*, ch. vi, pp. 118 ff.

or less uniform reaction, with which an organism would face a certain environment. Speaking broadly, we may say that each mental 'system,' each 'cortical set,' represents the adjustment of the organism to a particular environmental condition. Each adaptation marks a separate bit or pattern of experience upon the side of mind. In fact, experience might be considered as a mosaic, or rather panorama, of succeeding 'mental systems.' It is manifest that those organisms which have adapted themselves most readily and with the least friction have possessed, other things equal, the characteristics most favorable to survival. And so it is not surprising that we now find many 'short cuts' to adaptation and reaction,—that we find a verbal idea coming to represent a complex mental system, and reproducing in a condensed form all the essential conditions of a given environment.

This point of view also gives us a definite connotation for the term 'meaning.' Mind, from the beginning, has taken the form which the environment has given it.[1] The mental contents have always been 'meaningful' for the organism. A given complex of sensations is correlated with such and such a 'thing' of the outside world. The perception has such and such uses; the object is to be met by such and such adaptations. But the functions of the primitive mind were comparatively few. Each of its attitudes was self-sufficient. Every pattern was an independent pattern, and carried with it its own 'meaning' for the organism. But with the development of memory came the function of 'remote adaptation.'[2] The constant recurrence of given complexes in a multitude of different connections added something to the 'meaning' of a presentation: namely, the previous significance of similar presentations. As development continued and experience widened, the recognition of identity in 'meanings' became more and more automatic, became pushed back farther and farther into the margin of consciousness. In the adult apperceptive consciousness there is, as we have seen, no constancy in the quality and modality of the focal constituents. With very few exceptions—of which the 'constant supplements' are instances—the same symbol arouses at different times focal references which may be uniform or disparate, consistent or inconsistent; and yet the meaning of the symbol in combination with other symbols is perfectly unequivocal. It is reasonable to suppose that the marginal elements furnish the essential uniformity, and compensate the

[1] *Cf.* Titchener, E. B.: A Primer of Psychology. New York, 1899, p. 197.

[2] *Cf.* Bentley, I. M.: This *Journal*, Vol XI, No. 1 (1899), pp. 14 ff.

apparent inconsistencies.[1] In other words, the consciousnesses that are correlated with like adaptations are similar, not necessarily in their focal, but in their marginal constituents. Interpreted as marginal constituents, the kinaesthetic factors as well as the organic sensations come to their true rights. When the observer's attention is centered upon the stimuli—upon the symbols—he is in a 'sentence' mood, or a 'word' mood, or a 'mutilation' mood: *i. e.*, there is a certain adaptation in which certain marginal factors are constant. But when the attention shifts to the symbolized situation, the mechanism of the sentence, as such, becomes obscured; there is a new adjustment, resulting in another adaptation, in which certain other marginal factors are constant. In the one case, the sentence is apperceived as an orderly complex of sound units; in the other case it is apperceived as, in itself, a 'meaningful' unit.

The margin and the focus of consciousness play—if the expression may be pardoned—the one into the hands of the other; but the nature and modality of the elements which are to come into the focus, and the pattern of the elements which are to remain in the margin, are determined by the needs of the organism. It is the peculiar office of apperception, as the functional side of attention, to interpret the new presentation in the light of its significance to the organism. If it be a complex of visual sensations, supplemented by certain tactual and motor associates, and by the verbal idea 'table,' it may 'mean' an object to write on or an object to eat from, an object to be sold or an object to be bought, according as the mind is adjusted to the situation. If it be an auditory or visual complex, "The play is bad," it may 'mean' a mere combination of forms, a forbidden lead at whist, or a poorly staged drama. In each of these cases the presentation is met by a totally different adjustment of the organism, correlated on the side of mind with a peculiar and fitting pattern of consciousness. In this pattern certain typical sensations—centrally and peripherally aroused—occupy the margin of consciousness. They are determined largely by the individual, and are constant with him for this type of adaptation. Certain other elements occupy the focus of consciousness. These are determined almost entirely by the

[1] *Cf.* James, W.: Principles of Psychology, N. Y., 1890. Vol. II, p. 49. "The meaning is a function of the more 'transitive' parts of consciousness, the 'fringe' of relations which we feel surrounding the image, be the latter sharp or dim." James's position is practically that which we have taken above, except that he has approached the question from the standpoint of epistemology, rather than from the standpoint of genetic psychology. As a rule, an appeal to genesis is much more satisfactory than an appeal to epistemology, as the history of the psychological space theories abundantly shows.

existing environment, or by the exigencies of the situation which is faced.

Nor is this point of view inconsistent with that[1] which gives to the kinaesthetic elements the duty of carrying the meaning of a presentation. Reaction to the environment was the primary function of the primitive mind. When the development of memory brought with it the complications arising from the consciousness of former experiences, the motor memories became of fundamental importance in the new 'remote adaptation.' In the adult consciousness, as we have studied it, even symbolic apperception involves adjustment and adaptation, and adjustment and adaptation involve motor reactions. The kinaesthetic elements are predominantly marginal elements and the marginal elements 'carry the meaning.'

[1] *Cf.* Bawden: *op. cit.*, pp. 44 ff. Münsterberg's 'Action' theory of meaning must be left for a more detailed discussion. *Cf.*, in this connection, Münsterberg, H.: The Physiological Basis of the Mental Life. Science, N. S., IX (March 24, 1899) pp. 442 ff.; also Breese, B.: On Inhibition. *Psychological Review Monograph Supplement*, Vol. III, No. 1, pp. 47 ff.

MINOR STUDIES FROM THE PSYCHOLOGICAL LABORATORY OF WELLESLEY COLLEGE.

Communicated by MARY WHITON CALKINS.

IV. STUDIES OF THE DREAM CONSCIOUSNESS.

II.

By GRACE A. ANDREWS.

No psychologist has as yet discovered what every one of them desires: an experimental method of varying and repeating stimulations of the dream consciousness, which shall not at the same time vitiate the conditions of natural dreaming. The simplest method, that of giving the subject a definite stimulus just before he falls asleep, has been tested by Mr. Monroe[1] with visual stimuli and with tastes, and has recently been applied by the writer with visual stimuli. The subjects were six Wellesley College students, only one of them, however, the writer, trained in dream introspection. The materials were small squares of colored glass, about four by four inches, green and red, and illuminated from behind; similar squares of colored paper (a less adequate material); and two simple colored lithographs, one of a mounted horsewoman, the other of a woman surrounded by flowers. Just before going to bed the subjects of the experiment looked fixedly for five minutes at the colors, and for ten minutes at the pictures. The results are briefly these:

The trained subject has dreams on 3 out of 4 nights, probably suggested by the fixated colors or objects; and the average number of her remembered dreams is 5.4, as compared with an average of 3.4 on the nights of ordinary dreaming. One of the other subjects has these suggested dreams on two out of four nights, and has three cases of dreams which are possibly suggested by the experiment of a previous night. Of the other subjects there are two who have one dream each apparently suggested by the experiment; and, finally, there are two whose dreams seem unaffected.

For several reasons these experiments were discontinued before obtaining sufficient records for even a tentative conclusion. The inexperienced observers obviously required training in the observation and record of their normal dreams before the attempt to vary experimentally the conditions of their dreaming. There are, however, more fundamental difficulties which

[1] This *Journal*, Vol. IX, p. 413; Vol. X, p. 326.

seriously affect the value of such experimenting upon even the trained observer. There is the disadvantage attendant upon all investigation in which a person experiments upon himself; there is the further objection that stimulation and supposed result are separated by a considerable interval of time; and, finally, there is the lack of any observer of the attendant conditions.

The ideal method would provide for the excitation of the dreamer through auditory, olfactory or dermal stimuli, applied by the experimenter at different periods during the night. The practical difficulties, however, seem to be all but insurmountable. We have used, for instance, music boxes gently playing, intense and heavy odors, and cool surfaces for the immediate stimulation of dreams, but have failed in every instance, through prematurely waking the dreamer. Awaiting the more successful application of this method, or the discovery of a more effective one, there can hardly be too many records, by careful observers, of all their dreams during a series of nights. Such a record[1] of 118 dreams, was kept by the writer, during her second year of psychological study. The dreams were, with few exceptions, recorded continuously during six weeks immediately upon waking; the records were re-read upon the following day to discover their links with the waking life; and the records, as a whole, were carefully studied when entirely completed. The most significant results of the study may be summarized as follows:

Nearly 90 per cent. of these dreams are clearly suggested by the waking experience; more than one-half refer to occurrences of the same week, nearly one-half to the immediate environment, and two-thirds to people of the every-day life. Visual experiences predominate, as in the case of most dreamers, occurring in 96 dreams, that is in 81 per cent. of the total number. Nearly half of these dreams include color-sensations, and these have been a source of much æsthetic pleasure. On the other hand, only 7 dreams could be definitely remembered as containing auditory sensations, and few of the conversations seemed to be actually heard.

In most dreams of apparent taste and smell, sight sensation clearly does duty for both the others. The records, however, contain accounts of one clear, gustatory dream and of the two following olfactory dreams: I was holding a can from which came a vapor which the sponge absorbed. I soon began to be oppressed by the strong, stifling choking odor, and wondered how long I could stand it before becoming chloroformed myself. (I woke from the dream almost immediately and analyzed the experience as carefully as possible, remem-

[1] *Cf.* throughout M. W. Calkins, Statistics of Dreams. This *Journal*, V, p. 311.

bered that I had had no dream of smelling while keeping the record, and went to sleep again.) I then dreamed of looking off in the direction of Milton and of thinking and saying that beyond lay the ocean. I immediately got the keenest and most natural smell of wind from the flats and the delicious ocean odor. This gave me such intense pleasure, as it always does, that I awoke. (This dream, like the other, was carefully thought over upon waking, and seemed even more clearly to contain a pure and rich sensation of smell.) The following is the record of the taste dream: "Feb. 25, after 2.30 A. M. Dream 148. We were, I think, at the house in L, where we lived, eight years ago. We had a new kind of bluing; I saw some of it in blue streaks in the water. Father had put some in a well from which our drinking water came. I thought it was deadly poison and did not see how he could have been so careless. I had drank some of the water before I knew. It had a horrid metallic taste (like the taste of copper sulphate, which I got during the fall, from a drop on my blotting-paper).

The dreams seem, also, to include discomfort rather than physical pain. In a dream of being bitten by a kitten, whose red, open mouth I saw . . . I could not recall that I had suffered any pain. The experience seemed a complex of visual and tactual elements of an extreme intensity, rather than pain.

The frequent emotions of these dreams are, all of them, nearly as vivid and strong as those of the waking life, and many of them are stronger. Indeed, the dream emotion seems to me the most real element of the dream life and the one most to be depended on to follow the laws of waking consciousness. Although 29 of the 50 distinct and namable emotions are classed as unpleasant, yet the general affective impression of the dream, as a whole, was usually pleasant, perhaps because of the interest in the change of scene and the pleasant uncertainty of 'what next.' Æsthetic pleasure, also, often questioned as a dream-experience, forms an important part of dream pleasure, especially in dreams of color and of nature.

There are 34 clear instances of reasoning and argument—usually, of course, on absurd or trivial premises. In dream 13, for example, seeing "a doll which went by clock-work and was attached to a little cart, drawn by dogs which ran alongside," I "wondered how the machinery was regulated so that the doll just kept up with the dogs and what would happen if they ran faster." The composition, in dream 69, of the word 'Orthogeneous' in opposition to 'heterogeneous' is another case of reasoning, quite distinct from the mere association of words through *similar sounds*.[1]

Besides the natural association with each other, of the objects and events of these dreams, there is a frequent tendency

[1] *Cf.* James Sully, Illusions, c. 7, p. 181, note.

to connection between dreams of the same night. Thus, dreams 1 and 2, though of a totally different character, are both enacted on the deck of a steamer; and dream 3, of a vegetable garden, is followed by a dream of lettuce. This relatively uncontrolled association of the dream-life is responsible, of course, for the dream-story. There seems to be a close analogy between the way in which the events of the dream-story are evolved from our own imagination, with no plan or foreknowledge on our part, and the relation of the novelist to his characters, which in many instances assume a personality, speak, act and arrange their own destiny, almost without his control. The writer's dream-story is often both seen and heard as if read aloud by herself or another. Its events often have an unusual consistency, showing some unifying control by the mind. Often, also, it involves the phenomenon of so-called Double Identity. This may consist, in its simplest form, in merely watching the action of another (which is, nevertheless, my own dream-consciousness), or it may be something so complicated as to baffle description, the dreamer being at once spectator and actor and sharing in the emotions of each, as in the following dream: "Jan. 15, 5 A. M. Dream 35. A woman was being married in a cave, according to the ceremony of some savage tribe. I was, in quick succession—or at the same time, as it seems,—the woman herself and a spectator. The ceremony was connected with a magic stone, at first, small, greenish, with red spots, afterward larger, irregularly shaped. Then I was going down a street in Boston. When I reached a certain house, a very small man—the husband—appeared and led me up the steps and up a flight of stairs. After going up stairs, the woman or myself—I was both actor and spectator—threw herself into his arms, but the man was so small—a mere small boy—that he was overpowered by the onslaught, lost his balance and nearly fell to the floor. In my character of spectator I saw the ludicrous side of this, laughed and thought it very funny."

It will be observed that this dream involves no real 'change of identity.' The self of the dreamer is by turns observer and heroine, but does not disappear. however bewildering the change of circumstance. Indeed, these records confirm at all points every careful study of the dream experience. All such records disclose the intense individuality of the dream-life—even less susceptible than the waking experience of reduction to rigid general laws; they manifest also its inherent absurdities, due, of course, to the absence of waking criteria of reality; on the other hand, they bear unequivocal testimony to the presence in the dream-life of thought, moral reflection and æsthetic emotion as well as sensation and primitive feeling, and to the integral unity of the dreaming with the waking consciousness.

THE RELATION OF STIMULUS TO SENSATION. A REPLY TO MR. MAX MEYER'S CRITICISM ON PROF. C. LLOYD MORGAN'S PAPER.

By PROF. F. R. BARRELL.

The July number of this *Journal* contains a criticism by Mr. (? Prof.) Meyer on a recent paper by my colleague, Prof. Lloyd Morgan. It is stated that "the mathematical discussion contains several errors;" as I was responsible for a certain amount of advice in the preparation and for a final confirmation of the expression of Prof. Morgan's views, I have volunteered to reply to the criticism.

Mr. Meyer ought to have recognized that the whole sting of his criticism depends on a question of Definition. A circle, ellipse, or hyperbola has each its definition consecrated by time: a logarithmic curve, sine curve or the like has not. For the purpose of the paper under discussion we defined a 'logarithmic curve' [and the definition is obvious from the context][1] as one in which the "ordinates are in Geometrical Progression when the abscissae are in Arithmetical Progression" or *vice versa*: that is, the curve represented either by $y=Ae^{Bx}$ or by $y=A \log Bx$.

This curve is a direct expression of the Weber-Fechner law, it stands in a definite relation to the axes of co-ordinates—*i. e.*, in our case to the lines of no-sensation and no-stimulus—it has the essential and to my mind objectionable property that it cannot pass through the origin and it cannot embrace the obvious fact that no-stimulus is accompanied by no-sensation.

Further, the language of Prof. Morgan's paper distinguishes between a 'part of a curve' and the 'complete curve:' this is in accord with my own habit; thus, I would not call a Gothic arch circular though it be composed of arcs of circles; nor would I call the curve of cosines the curve of sines, though it be merely the same curve in a different phase. This habit may not be as general as we imagined, and I would not seek to impose it on Mr. Meyer.

Prof. Morgan enunciates the law A "*Equal increments of*

[1] Prof. Morgan's phrase "*logarithmic, as it should be, if the Weber-Fechner formula holds good*," may fairly be claimed as an explicit statement of the definition, for the curve $y=Ae^{Bx}+C$ is *not* 'as it should be,' if the Weber-Fechner law be true.

sensation are produced by increments of excitation in Geometrical Progression."

The Weber-Fechner Law B may be tersely enunciated "*Sensations increasing by equal increments are produced by excitations in Geometrical Progression.*"

Mr. Meyer overlooks the fact that law A is merely a particular case of law B, and, moreover, that it is the only case which cannot possibly hold good in the lower stages of sensation.

In my note to Prof. Morgan's paper[1] I showed how the mathematical expression of his law led to the Differential Equation

$$\frac{dy}{dx}\,\frac{d^3y}{dx^3} = \left(\frac{d^2y}{dx^2}\right)^2 \quad . \quad . \quad . \quad (I)$$

it is easy to show that the Weber-Fechner law leads to the equation

$$y.\,\frac{d^2y}{dx^2} = \left(\frac{dy}{dx}\right)^2 \quad . \quad . \quad . \quad (II)$$

Mr. Meyer must know the fundamental distinction between an equation of the third order and one of the second: viz.—the solution of one contains *three arbitrary constants*, that of the other contains *two*.

Thus

(I) leads to $y = Ae^{Bx} + C = A10^{bx} + C \quad . \quad . \quad . \quad (III)$

(II) leads to $y = Ae^{Bx} \quad = A10^{bx} \quad . \quad . \quad . \quad (IV)$

the similarity between these two results, and the accident that by putting C=o, or by adjusting the axes, III reduces to IV, ought not to blind us to the above essential difference; nor ought we to be influenced by the fact that any arc of III can be superposed in Euclidean fashion upon the corresponding arc of IV.

The advantage of possessing three arbitrary constants A, B, C as in (III) is seen as follows:—Since any arbitrary scales may be chosen for representing stimulus and sensation, it is convenient in each experiment to represent the extreme sensation and extreme stimulus each by 100: Thus III must be satisfied by y=100, x=100:

$$\therefore\ 100 = A10^{100b} + C \quad . \quad . \quad . \quad (V)$$

further, it is axiomatic that 'no-stimulus' is accompanied by 'no-sensation' [this may be a psychological blunder; if so, as a

[1] Psychological Review, VII, No. 3, pp. 217-233, 1900.

mathematician I must be pardoned], hence III must be satisfied by y=0, x=0

$$\therefore \quad 0 = A\,10^{0} + C \quad \therefore \quad c = -A$$

which by substitution in (V) gives

$$100 = A\,10^{100b} - A$$

i. e. $$100 = A\,(10^{100b} - 1) \quad . \quad . \quad . \quad \text{(VI)}$$

this single relation between A and b leaves at our disposal one other relation between them, and this we utilize to give character to the sensation under discussion by making the curve pass through any single point determined in the experiment: in the case of White on 'Morgan's Black' this was the point y=27, x=50 giving

$$27 = A\,(10^{50b} - 1) \quad . \quad . \quad . \quad \text{(VII)}$$

in the case of Red on 'Morgan's Black' it was y=35, x=50, giving

$$35 = A\,(10^{50b} - 1)$$

Equations VI and VII determine the values A=15.85, b=.008639.

If we attempt to treat formula IV in the same way, we begin as before:—put y=100, x=100

$$\therefore \quad 100 = Ae^{100b} \quad . \quad . \quad . \quad (V^1)$$

now put y=0, x=0

$$\therefore \quad 0 = A\,10^{0.b} \quad . \quad . \quad . \quad (VI^1)$$

Unfortunately this cannot be satisfied by finite values of A and b, and we are confronted by the fundamental objection to the Weber-Fechner law—it cannot be applied to the low stages of sensation. But supposing even that (VI^1) could be satisfied by finite values of A and b, then V^1 and VI^1 between them would use up both the available constants, and we should have no constant left with which to give character to the particular sensation under investigation.

This point is brought out clearly by Prof. Morgan in his Fig. 4 in a comparison (which Mr. Meyer erroneously condemns) between the curve derived from his own experiment and the 'logarithmic-curve-as-it-should-be-if-the-Weber-Fechner-formula-holds-good,' which fits it most closely.

This family of curves being represented by $y = A\,10^{bx}$, any member of the family is completely determined by two given points. How were these two points to be selected? As explained above, the desirable point y=0, x=0 had of necessity to be abandoned: then in order to secure some degree of proximity between the curves the other extreme point y=100, x=100 was abandoned: finally, as clearly stated by Prof. Morgan and *quoted by Mr.*

Meyer the stages 6 and 14 were selected for coincidence: from the tabulated results we have

at stage 6 $y=13$, $x=30$ $\therefore$ $13=A10^{30b}$
at stage 14 $y=48$, $x=70$ $\therefore$ $48=A10^{70b}$.

These give $A=4.881$, $b=.01418$, hence the equation to the broken curve is $y=4.881\times 10^{.01418x}$ and, on the assumption that Prof. Morgan's black gives a reasonably approximate zero of stimulus as a basis for calculation, the contrast between this broken curve and the experimental curve illustrates well the difference between the new law and the old.

The latter part of Mr. Meyer's paper is interesting, as it brings out the simple mathematical fact that any member of the family of curves $y=A(10^{bx}-1)$ may be converted into any other one by a suitable increase or decrease of both the horizontal and vertical scales of representation: this property is so familiar in the case of ellipses and certain other curves that it did not seem necessary to call attention to it. Moreover, I cannot see that Mr. Meyer's method of comparing the results 'White on Black,' 'Red on Black,' 'Blue on Black' by adjusting the scales of the second and third so as to make them coincide with positions of the first, is intrinsically superior to Prof. Morgan's method of comparison by means of three distinct curves bridging over the same interval.

Mr. Meyer's method may, however, be the better if his suggestion be correct that the thing dealt with in the experiment was intensity of illumination rather than toning of color; this idea had previously suggested itself to Prof. Morgan, who said in his paper "so far as the colors are concerned the results appear to be due rather to the relative intensities of stimulation or excitation of the retina than to the effects of color as such."

The only fault which I can detect in Prof. Morgan's exposition of his results is that he neglected to point out the patent fact that by assuming (without any experimental basis for the assumption) that his black contained precisely 15.8% of white and 40.8% of his red (or of their illuminations) he would bring his results in line with the Weber-Fechner formula: this omission left it open to Mr. Meyer to assume that the fact had not been noted.

In conclusion I must add that even if the law "*Equal increments of sensation are produced by increments of excitation in Geometrical Progression*" be merely considered as a modified statement of Weber's law, yet it is a very material improvement on the old mode of expression, for it deals with the only things which are actually estimated in these and similar experiments, where the true zero of stimulus is difficult to ascertain, namely, *increments* of stimulus and *increments* of sensation.

Further, although the formula $y=A(10^{bx}-1)$ may not stand the ultimate test of being applied to low stages of sensation in cases where the zero of stimulus can be absolutely ascertained (as, *e. g.*, in estimating saltness of dilute solutions) yet it has the *prima facie* advantage that it permits us to work downwards without break of continuity to the point "no-stimulus, no-sensation," and that, as Prof. Morgan pointed out in his paper, it gives near the threshold of sensation an arithmetical progression of stimulus, which accords with results obtained by the pupils of Hering.

I am, of course, aware of the accepted opinion that starting with no-stimulus, and gradually introducing stimulus, some finite stimulus must be reached before any sensation is recognized; this seems to indicate some discontinuity at the inception of sensation, and might necessitate a corresponding discontinuity in the formula representing it. Yet, although some such explosive origin may be possessed by sensation, the hiatus between the zero and the starting point of sensation must be so slight, that it is desirable if possible in this, as in physical phenomena, to bridge over the hiatus by a formula which will extend down to the origin.

PSYCHOLOGICAL LITERATURE.

Psychologische Schulversuche mit Angabe der Apparate. HOFLER und WITASEK. Barth, Leipzig, 1900. pp. viii+30.

The above is, we believe, the first collection of elementary psychological experiments published in German. It consists of directions for seventy-five simple experiments, and is designed for use in gymnasia, normal schools, and similar institutions where students begin the subject. For the sake of having some systematic order of presentation the authors have followed the *Psychologie* of Höfler, and cross references are made to both the larger and smaller forms of that work. The experiments have all proved their value in actual teaching, and can be performed with a minimum of apparatus—a considerable number without any. Several are new in form and a few in substance. A list of standard apparatus (with prices as furnished by W. J. Rohrbeck's Nachfolger, Wien I., Kärntnerstr. 59) is appended. The collection is one that should prove valuable to any one engaged in teaching elementary psychology. E. C. S.

On a Flicker Photometer. OGDEN N. ROOD. Science, N. S. VII, 1898, 757-759.

On Color Blindness: On the Application of the Flicker Photometer to the Quantitative Study of Color Blindness. OGDEN N. ROOD. *Ibid.*, 785-786.

On the Flicker Photometer. OGDEN N. ROOD. American Journal of Science, Ser. 4, VIII (1899), 194-198.

On Color-vision and the Flicker Photometer. OGDEN N. ROOD. *Ibid.*, 258-260.

The first and third of these papers describe means by which Prof. Rood's flicker method of photometry may be applied to colored lights, as, for example, those of incandescent lamps, and give experimental data showing the accuracy of the method.

The second and fourth are of more immediate interest to students of color-vision. In the second paper are given results of measurements by the flicker method of the relative brightness of red and green lights as seen by observers known to be defective in the vision of red as compared with the brightness of the same colors as seen by Prof. Rood himself. The differences are of striking amount, the color-blind observers finding the red and green lights respectively about 20%, and 85% as bright as they seemed to Prof. Rood, on the assumption that he and the other observers were equally sensitive to violet blue. Another observer, partially red blind, saw red about 63% as bright as Prof. Rood. The fourth paper gives the results of tests by the same method upon the eyes of "normal" observers. These also showed distinct differences in the relative brightness with which they saw red, green, and violet blue, though the degree of difference was in most cases less than even with the green in the former cases. Classified with reference to green, they form two pretty distinct groups: one in which green is weak compared with red and violet blue, and the other in which it is stronger than either. It would seem that Prof. Rood has here under investigation the same differences of "normal" vision as

have previously been noted by Rayleigh and Donders (see Helmholtz, *Optik*. 2te Aufl., p. 359), and that his flicker photometer offers a particularly convenient method of investigating them. E. C. S.

The Behavior of Unicellular Organisms. H. S. JENNINGS. Biological Lectures from the Marine Biological Laboratory of Woods Holl, 1899. pp. 93-112. Seventh Lecture.

Studies on Reactions to Stimuli in Unicellular Organisms.—VI. On the Reactions of Chilomonas to Organic Acids. H. S. JENNINGS. American Journal of Physiology, III, 1900. 397-403.

Reactions of Infusoria to Chemicals: A Criticism. H. S. JENNINGS. American Naturalist, XXXIV, 1900. 259-265.

In the first of these papers Dr. Jennings considers the behavior of unicellular organisms with a view to determining whether their movements are of such a character as to explain the migrations of cells in the embryo as some embryologists have been ready to assume. In the course of his discussion the author formulates his observations with reference to the activities of these low forms in a clear and interesting manner, illustrating them chiefly by the behavior of paramecia. Three forms of activity are found: "(1) One is the thigmotactic reaction. Starting with the moving infusorian, we find that it reacts to contact with solid bodies of a certain physical texture by suspending part of the usual ciliary motion, so that locomotion ceases and the organism remains pressed against the solid." "(2) If we start with the resting individual, the simplest reaction to a stimulus is the resumption of the usual forward motion. This is the reaction that is produced when the solid substance against which the creature is resting is removed; it is also produced in some infusoria when the posterior part of the body is stimulated mechanically." "(3) The third, and, for our purpose, most important reaction, to which most of the so-called tactic or tropic phenomena are due, may occur in either active or resting animals. It is a reflex consisting of the following activities: the animal swims backward, turns toward one structurally defined side, then swims forward. This reaction is produced by chemical stimuli acting upon any part of the body or upon the entire body at once, by osmotic stimuli, by heat, by cold, by mechanical shock. Its general effect is to take the organism out of the sphere of operation of the agent causing the stimulus, or to prevent it from re-entering." These creatures therefore have a crude adaptation of reflex movements to the nature and place of the stimulus received. Their movements are neither on the one hand the result of mere chemical or physical attractions or repulsions, nor on the other of complex psychic conditions, but are "of the same order as the motor reflexes of higher animals." This is a somewhat different and doubtless better considered statement than that of the author in the final paragraph of his article in this *Journal* (Vol. X, 1898-99, p. 515) where he speaks of them as "comparable in all essentials to those of an isolated muscle." The activities of unicellular organisms being of this reflex character and not of the more purely chemical and physical sort, the writer is inclined to decide against their being useful in solving the original question of cell migrations in the embryo.

The other two papers mentioned above are more or less controversial and devoted to clearing up differences between the observations of the author and those of Garrey, who has also published along nearly the same lines. The author seems successful in showing that the observations of Garrey are in accord with his own general principle quoted as (3) above. E. C. S.

Einführung in die Philosophie der reinen Erfahrung, von JOSEPH PETZOLDT. B. G. Teubner, Leipzig, 1900. pp. 356.

The author postulates the necessity of psycho-physical parallelism for the understanding of psychic events; then takes up the unequivocal ordering of psychic to physical processes; defining the biological sense of brain life; the determination of the elements and affective characters; the determination of the degree of consciousness; the qualities of otherness, sameness, being, certainty and knowledge; the distinction between fact and thought; the logical, æsthetic and ethical characteristics; and finally treats the significance of the critique of pure experience.

Psychological Studies, by HARLOW GALE. No. 1, July, 1900. pp. 175. Minneapolis, 1900.

The first article on our nervous system and its use contains twenty-one original microphotographs and twenty-nine reproductions of schematic figures. Other interesting articles are on the psychology of advertising; the vocabularies of two children of one family to two and one half years of age; taste and smell in articles of diet; the case of alleged loss of personal identity; and psychical research in American universities. A valuable catalogue of lantern slides is appended, duplicates of which can be supplied at moderate rates.

Psychologie des Willens zur Grundlegung der Ethik, von HERMANN SCHWARZ. W. Engelmann, Leipzig, 1900. pp. 391.

The metaphysics of the will; will as a unitary power; its psychology; acts of will with the accompanying pleasure and pain; under the direction of the will energies; the extreme forms of empirical will psychology; their non-objectivity; the lie of consciousness as the motive and opinion and the change of the former; and the multiplicity of aims are discussed. The second part of the book considers normative laws of the will or the doctrine of the higher faculty of desire and preference. The will acts are primarily distinguished as due to analytic or synthetic preference.

Les Philosophes Géomètres de la Grèce, Platon et ses Prédécesseurs, par GASTON MILHAUD. F. Alcan, Paris, 1900. pp. 387.

In the first part the author discusses the predecessors of Plato, with chapters on the early Ionians, the Pythagoreans, Eleatics, and Anaxagoras and Democritus. In the second part he discusses Plato under the rubrics dogmatism, idealism, mechanism and synthesis. A convenient summary chapter résumés his conclusions.

The Order of Development of Color Perception and of Color Preference in the Child, by W. A. HOLDEN and K. K. BOSSE. Reprint from the Archives of Ophthalmology, Vol. XXIX, No. 3, 1900. pp. 261–277.

The author's conclusions support singularly well the Gladstone theory of the development of the color perception in the human race, although we must go down far below primitive man to find the beginning of color perception. Red seems to lead in the preference of infants, and then comes blue, and later orange, yellow and green.

Le Crime et Le Suicide Passionnels, par LOUIS PROAL. F. Alcan, Paris, 1900. pp. 683. Price, Fcs. 10.

Proal has given us here a comprehensive monograph on single and double passional suicide, its relations to love, hate, seduction, jealousy, passion, precocity, contagion, the effects of romance and the theater, and finally the responsibility and the possibility of diminishing this crime.

Vorlesungen über Psychopathologie in ihrer Bedeutung für die normale Psychologie mit Einschluss der psychologischen Grundlagen der Erkenntnistheorie, von GUSTAV STÖRRING. W. Engelmann, Leipzig, 1900. pp. 468. Price, Mks. 9.

The writer is a private docent of philosophy at Leipzig and here discusses insanity in its relations to normal psychology and the theory of knowledge. He is most interested in illusions, defects of speech and memory, but the whole twenty-five lectures present the subject from an interesting and novel point of view.

Der Wert der Kinderpsychologie für den Lehrer, von J. STIMPFL. E. F. Thienemann, Gotha, 1900. pp. 28.

This pamphlet describes quite fully the progress of child study in America and reprints a number of questionnaires of Hall and others.

Das Blut im Glauben und Aberglauben der Menschheit, von HERMANN L. STRACK. Oskar Beck, München, 1900. pp. 208.

This is an interesting study of folk medicine and Jewish blood rites, which appeals chiefly to folk-lorists and those interested in the Old Testament. The persistent conception that the soul is blood animates it throughout.

A Buddhist Manual of Psychological Ethics of the Fourth Century B. C., by CAROLINE A. F. RHYS DAVIDS. Royal Asiatic Society, London, 1900. pp. 393.

The genesis of thought and then the good states of consciousness, the bad and intermediate states; and the eliminations desirable are the leading themes of this difficult and strange but fascinating old work.

The History of the Higher Criticism of the New Testament, by HENRY S. NASH. The Macmillan Co., New York, 1900. pp. 192. Price, 75 cents.

The chapters are criticism and interpretation; the Bible's definition of revelation and the ideal Bible study that goes with it; how criticism became necessary; how its possibility was given; how it was realized; its preliminary work; turning points; tendencies; the schools; the historic spirit; and the inspiration of criticism.

The Biblical Theology of the New Testament, by EZRA P. GOULD. The Macmillan Co., New York, 1900. pp. 221.

This is a study the author made with his students in the Philadelphia Divinity School and treats Jesus, God, his kingdom, Jesus' estimate of himself, of man, his doctrine of the last things, the apostles, Paul's teaching, the later apostolic writings, the non-Johannean writings of the Alexandrian period, and the Johannean writings.

Evolution and Theology and other Essays, by OTTO PFLEIDERER. Edited by Orello Cone. Adam and Charles Black, London, 1900. pp. 306.

The other essays referred to in the title are theological and historical science; Luther as the founder of Protestant civilization; the essence of Christianity; the notion and problem of the philosophy of religion; the task of scientific theology for the church of the present; Jesus' foreknowledge of his sufferings and death; the national traits of the Germans as seen in their religion; is morality without religion possible or desirable? free from Rome.

COMMUNICATION.

To the Editors of the *American Journal of Psychology*,

GENTLEMEN:

I regret to say that through inadvertence no mention was made in my recent paper on "The Psychology of Conjuring Deceptions" of Professor Joseph Jastrow's important study of the same subject (The Psychology of Deception, *Pop. Sci. Mo.*, 1888, Vol. XXXIV, pp. 145-157).

Professor Jastrow was, so far as I know, the first to enter upon this field, and subsequent investigators naturally find themselves under obligation to him. The writer's attention has also been called to the fact that through Dessoir's lack of acknowledgment to this same author several citations have been credited to Dessoir that are to be found in Jastrow's original paper.

Respectfully,
NORMAN TRIPLETT.

Clark University, Sept., 1900.

BOOKS RECEIVED.

BELOT, BERNES, BUISSON, et des autres. Questions de morale. F. Alcan, Paris, 1900. pp. 332. Price (bound) Fcs. 6.

BOUTROUX, PIERRE. L'imagination et les mathématiques Selon Descartes. F. Alcan, Paris, 1900. pp. 47. Price Fcs. 2.

DURAND, J. P. (de Gros.) Variétés philosophiques. Deuxième éd., revue et augmentee. F. Alcan, Paris, 1900. pp. 335. Price Fes. 5.

HUGHES, HENRY. Die Mimik des Menschen auf Grund voluntarischer Psychologie. Mit 119 Abbildungen. Johannes Alt, Frankfurt, a. m., 1900. pp. 423. Price, Mks. 14.

MILHAUD, GASTON. Les philosophes géomètres de la gréce. Platon et ses prédécesseurs. F. Alcan, Paris, 1900. pp. 388. Price, Fcs. 6.

PROAL, LOUIS. Le crime et le suicide passionnels. F. Alcan, Paris, 1900. pp. 683. Price, Fcs. 10.

RIBOT, TH. Essai sur l'imagination créatrice. F. Alcan, Paris, 1900. pp. 304. Price, Fcs. 5.

STERN, L. WILLIAM. Ueber Psychologie der individuellen Differenzen. (Ideen zur einer "Differentiellen Psychologie.") J. A. Barth. Leipzig, 1900. pp. 146. Price, Mks. 4.50.

STOCKHAM, ALICE B. Tolstoi: A man of peace. A. B. Stockham & Co., Chicago, 1900. pp. 84. Contains also Tolstoi: The new spirit, by Havelock Ellis. pp. 87-140. Price, $1.00.

STÖRRING, GUSTAV. Vorlesungen üeber Psychopathologie in ihrer Bedeutung für die normale Psychologie mit Einschluss der Psychologischen Grundlagen der Erkenntnistheorie. W. Engelmann, Leipzig, 1900. pp. 468. Price, Mks. 9.

ZIEHEN, TH. Leitfaden der Physiologischen Psychologie in 15 Vorlesungen. Fünfte Auflage. Gustav Fischer, Jena, 1900. pp. 267. Price, Mks. 5.